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COMPETITIVE EXAMINATIONS will be held by the Municipal Service Commission of New York, as follows: Aug. 25, for inspector of water meters and consumption, $1,000 annual salary; Aug. 29, for electrical engineer, annual salary, $3,000 or more. There is also a vacancy for Superintendent of Telegraph, salary $3,000. On Aug. 22, an examination will be held for an inspector of steel and iron, $1,200 to $1,500 per annum.

THE INCREASE IN THE CORPS OF CIVIL ENGINEERS of the U. S. Navy results in three existing vacancies —and there will be three more on Jan. 1, 1903. The rules governing appointments to this corps can be obtained from the U. S. Navy Department. In general terms, the candidates must be between 27 and 35 years of age; they will be examined as to physical fitness first; and an examination for mental and professional standing follows. Each applicant must be an American citizen, and must present testimonials as to character, evidence of having received a degree as civil engineer from some reputable technical school, with a record of at least five years of practical experience as a civil engineer. Examinations will be held on Sept. 29, 1902, at the Civil Service Commission Rooms, Post Office, Chicago, and at the navy yard in New York. Permits for these examinations must first be secured from the Navy Department.

AN ASPHALT PAVING CONTRACT at Washington, D. C., has been awarded to the Barber Asphalt Co., for $1.56 per sq. yd., some 20 cts. less than last year's price.

A PERPETUAL INJUNCTION AGAINST POLLUTING the Kennebec River and its tributaries with sawdust and other refuse has been granted against 49 defendants in a suit brought by the Hollingsworth & Whitney Co., of Waterville, Me.

THE PROVIDENCE WATER FILTRATION PLANT is to be built for $196,150, according to the contract signed a few days ago by Everson & Shaw, of Providence. The only other bidder, James J. Newman, wanted $290,000 for the work. The engineer's estimate was $205,220. The prices named do not include the electrical pumping plant, which is to be built under a later contract.

THE GROWTH OF MUNICIPAL OWNERSHIP of street railways and omnibuses in Great Britain during the seven years ending June 30, 1901, is shown by the following figures from "Duncan's Manual of Tramways, Omnibuses and Electric Railways:" The mileage of municipal undertaking has increased from 315 to 680 miles, and the number of undertakings from 37 owned and 3 worked to 99 owned and 44 worked by municipalities. The figures begin with 1894 because "this is the last year previous to the suspension of the Standing Orders which prohibited" street railway operation by municipalities."

WORK ON THE DEVELOPMENT OF WATER POWER in the Chicago Drainage Canal has been commenced by the trustees of the Sanitary District, says the Chicago "Chronicle." The plans call for a plant that will develop 24,000 HP., located near 16th St., in Lockport. The estimated cost is about $3,000,000; but for this outlay the district expects to have a power plant that will yield an annual income of $000,000. The Gaylord counter interest has renewed its application for an injunction to restrain the trustees from building dams, etc.

IN CONNECTION WITH THE HANKOW-CANTON Railway in China, recently reported as going under construction, Mr. Wm. Barclay Parsons, M. Am. Soc. C. E., and Chief Engineer of the New York Rapid Transit Ry., and also of this Chinese road, desires us to say that there are no vacancies on the engineering corps of the Hankow-Canton Railway, and that therefore no new appointments will be made.

THE OLDEST WORKING LOCOMOTIVE in the world, says "The Iron and Coal Trades Review," was built by Stephenson for the opening of the Helton Railway in 1822, and is still hauling coal at the Helton Colliery, England. While many of the parts have been renewed, the general design—excepting the cab—remains as originally constructed. This engine weighs 15 tons, and has a hauling capacity of about 120 tons at 10 miles per hour. It is now to be retired, and it will be deposited in the Durham College of Science, Newcastle-on-the-Tyne. Stephenson's "No. 1 Locomotive," now on exhibition at Darlington, was built in 1825 for the Stockton & Darlington Railway. It worked on the railway until 1850, was used for colliery purposes until 1857, and was then withdrawn from service.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the New York, Ontario & Western Ry. at Horton, N. Y., on Aug. 3. Two milk trains were ordered to pass at Horton, but the northbound train passed the siding and collided with the other on a curve just beyond. Four trainmen were killed, among them the engineer and fireman of the train that caused the collision. ——On July 30 a fast mail train on the Pennsylvania R. R. jumped the track near Johnstown, Pa., and went over a high bluff, killing two of the train crew.

A FATAL ELECTRIC RAILWAY ACCIDENT occurred on the Albany & Hudson Ry., near Stockport, N. Y., on Aug. 2. The line is single track and is operated by third-rail. It is reported that the contact shoe of one car got out of order and the car had to stop; a car following a short distance behind was not properly signaled and in consequence crashed into the other. Both cars were crowded with excursionists, and in the collision two of them were killed and a score of others injured.

LOCAL EARTHQUAKE SHOCKS of some violence did considerable damage at Los Alamos, in Santa Barbara County, in southern California, on July 31. The region affected is within a few miles of the Pacific. Much oil is produced in the neighborhood, and about 100 miles to the northeast are the oil and asphalt fields of Kern County. No lives were lost in the disturbances, but much property damage is reported.

THE BALDWIN-ZIEGLER ARCTIC EXPEDITION has returned without any definite results. This was the best equipped expedition that ever set out; but the net result seems to be the establishment of depots of condensed food in Rudolf Land, at 81° 33" north latitude, and a third on Greely Island. All channels through Franz Josef Land are reported as blocked with ice during the autumn of 1901. There is also a report of dissension among the officers of the expedition.

THE GERMAN CEMENT SYNDICATE has failed in its effort to control production and regulate prices, and it has dissolved, says U. S. Consul T. G. Albert, of Brunswick, Germany. This failure is due to the large number of new factories started in the last few years. There is now a conflict of extermination between the larger factories and the small ones. The price of cement is now said to be 20% below the cost of production in well-conducted works. One factory reports that lime costs $30 per car load, while the cement is sold in large orders at $32.50 per car load. The domestic consumption and export of German cement amounts to 14,000,000 barrels, while existing factories have a production capacity of 30,000,000 barrels. There are now about 84 large cement factories in Germany, as compared with 69 in 1899; and in some of the old ones the producing capacity has been much increased.

A LARGE SHIP CRANE has been built at the works of the Howaldt Co., at Kiel, Germany. It is a revolving crane set on a pier, 52 ft. wide, with the carrying arm 142 ft long, and the balance-arm 30 ft. long. The whole height of the crane is 133 ft. Electric power is used, and the crane will lift 150 tons at the rate of over 3 ft. per minute; it can make a complete revolution in 10 minutes. It is used in loading and unloading ships in process of construction or repairs.

THE ELIMINATION OF SO-CALLED FIREPROOF wood in the construction of high buildings is before the Aldermen of New York. Mr. George Edward Harding, a prominent architect of New York, vigorously protests against this proposed prohibition, advocated, he says, by Mr. Edward Atkinson, of Boston. Mr. Harding does not claim that such wood is fireproof, but he asserts that it is fire-resisting; and he advances proof to show its value in case of fire. He contends that the wood sheathed by metal, proposed as a substitute, will be easily destroyed in case of fire, and is far inferior to the treated wood. Mr. Harding claims that the Boston tests of fireproof wood, conducted by Mr. Atkinson, prove the fire-resisting qualities of properly treated wood.

A NEW PLATE-HARDENING PROCESS has been invented by Lieut. Cleland Davis, U. S. N. The process is not exactly described, though successful tests have been made at Bethlehem. The plan contemplates the use of heavy currents of electricty directed upon the heated armor-plate; and it is claimed that by so doing a portion of the carbon of the anode is carried far into the interior of the plate, resulting in extreme hardness. The claim is made that the same result is secured in five hours that requires two to three weeks "soaking" by the Harvey or Krupp process; and Lieut. Davis estimates that he can save from 20 to 50% in the weight of a plate giving resistance equal to a Krupp plate.

IRON AND STEEL PRODUCTION IN THE UNITED States in 1901 is treated by Mr. James M. Swank, in the Mineral Resources of the United States. The product, compared with that of 1901, is as follows:

	1900. Long tons.	1901. Long tons.
Pig iron	13,789,242	15,878,354
Bessemer steel ingots	6,684,770	8,713,302
Open-hearth steel	3,398,135	4,656,309
Steel of all kinds	10,188,329	13,473,595
Rolled steel, including rails	9,487,443	12,349,327
Iron ore mined	27,553,161	28,887,479
Lake Superior ore shipped	19,059,393	20,589,237
Connellsville coke shipped, short tons.	10,166,234	12,609,949
Pocahontas coke shipped, short tons.	1,341,444	1,279,972

In 1901 there was a small decrease in the output of iron and steel cut nails, but an increase of 2,569,843 kegs of iron and steel wire nails. The total value at the mines of the iron ore produced was $49,256,245, an average of $1.71 per long ton, as compared with $2.42 in 1900. In 1901 the average price of gray forge pig iron, at Pittsburg, was $14.20 per long ton, as compared with $16.90 in 1900; Bessemer pig iron, $15.93, as compared with $19.49 in 1900; steel rails at mills, $27.33 per ton, as compared with $32.29 in 1900. The total imports of iron and steel in 1901 amounted to $20,394,995, as against $20,443,011 in 1900.

THE AMERICAN IRON AND STEEL ASSOCIATION has reported upon the production of pig iron in the United States for the first half of 1902. This half-year's production amounts to 8,808,574 gross tons, against 7,674,613 tons in the first half of 1901. For the year ending June 30, 1902, the production was 17,012,315 tons. The total production for the first half of 1902 in England and Germany amounted to 7,761,830 and 7,736,663 gross tons, respectively. For the period in question, Bessemer pig iron amounted to 5,105,932 gross tons; basic pig iron, 1,053,274 gross tons; charcoal pig iron, 186,098 gross tons; spiegeleisen and ferro manganese, 118,982 gross tons. Each of these products greatly exceeds the output for the same period in 1901. There were 286 furnaces in blast on June 30, 1902, against 266 on Dec. 31, 1901, and 259 on June 30, 1901.

THE CLAY-WORKING INDUSTRIES of the United states will be treated by Mr. Jefferson Middleton in the forthcoming Mineral Resources of the United States for 1901. The total value of the products of clay for 1901 was $110,211,587, as compared with $96,212,345 in 1900. Of this total brick and tile represent 79.62%. The total value of all imports of clay and products of clay was $9,681,411, and the value of clay wares exported from the United States was $1,068,409.

A TREE 51 FT. IN DIAMETER has lately been discovered on the government reservation near Fresno, Cal. Six feet from the ground its circumference is 154 ft. 8 ins.

THE COLORADO DESERT IS THE HOTTEST PLACE in the world, says Prof. Mark W. Harrington, late Chief of the Weather Bureau, in his bulletin on The Climate and Meteorology of Death Valley, California. In this bulletin he gives the following comparative table of hottest places:

	Max. temperature, Fahr., in shade
Mammoth Tank, Colorado desert	128.0°
Pachpadra, Rajpootana, India	123.1°
Jacobabad, Sinde, India	122.2°
Death Valley, Cal.	122.0°
Dera, Ismaeel, Punjab, India	121.5°
Hyderabad, Sinde, India	121.0°
Gardaia, Algerian Sahara	118.4°
Mooltan, Punjab, India	118.4°

ELECTRIC LIGHTS FOR PROPOSED ISLES OF SAFETY IN NEW YORK CITY.

The Municipal Art Society of New York recently held a competitive exhibition of electric light standards, or electroliers, for use in connection with the proposed "isles of safety," or refuge points in the middle of the streets at crossings having a dense traffic. The award made at this exhibition was as follows: 1st prize, $500, to Victor A. Ciani, New York; 2d prize, $100, to Henrik Wallin, New York; 3d prize, $50, to Willkenson & Magonigle, New York, and Honorable Mention, to Mrs. Edith W. Burroughs, Flushing, L. I.

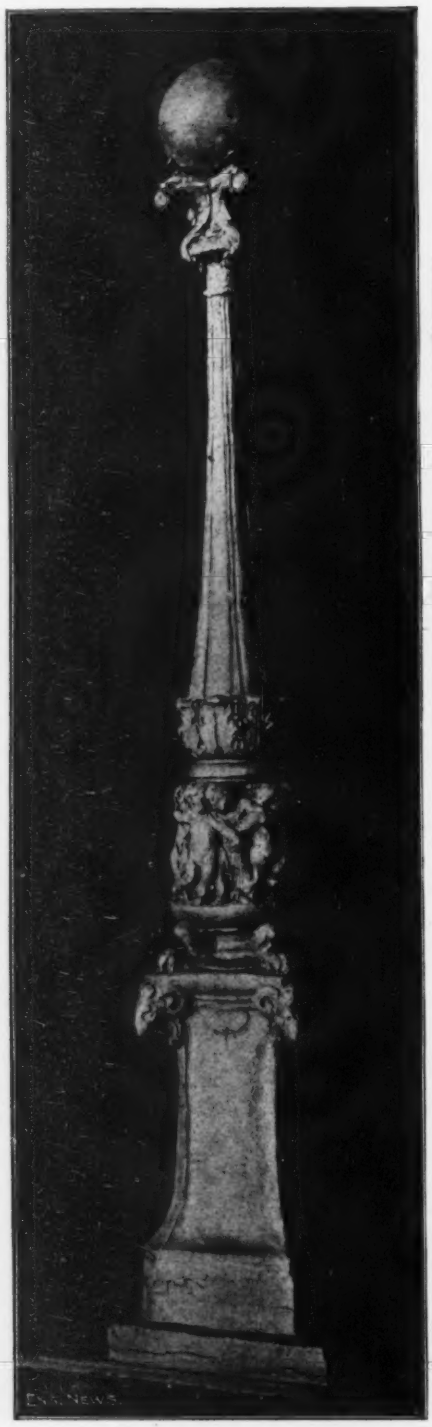

Fig. 1. First Prize Design.

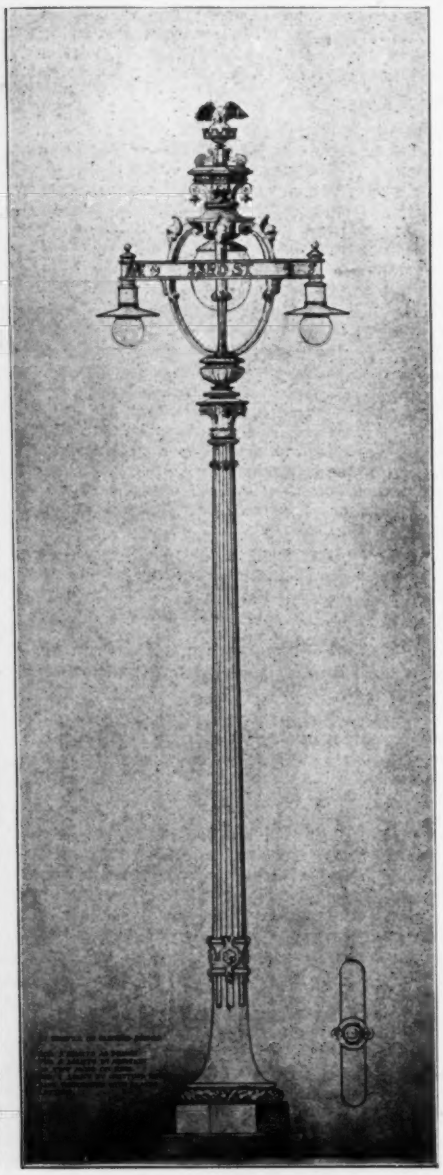

Fig. 2. Third Prize Design.

THE MUNICIPAL ART SOCIETY'S PRIZE DESIGNS FOR ELECTRIC LIGHT STANDARDS FOR ISLES OF SAFETY IN NEW YORK CITY.

The isle of safety has long been a feature in the streets of London and some large Continental cities, and it is recognized as a useful means of protecting foot passengers against reckless driving. In a rudimentary form, the refuge isle has been introduced into New York, with wooden platforms fastened to the asphalt and protected by wooden railing. There is now an effort to locate more permanent isles of refuge, particularly at crowded points on Fifth Ave., and in this connection the Municipal Art Society is endeavoring to combine with usefulness to the citizen features which will also beautify the city. The congested points under consideration by the Society are at 14th St. and Fifth Ave., 34th St. and Fifth Ave. and 42d St. and Fifth Ave. When the refuges have proved their value at these points the system may be extended to minor streets.

The four designs selected have merit, and either one would be far in advance of any of the street lampposts familiar to the citizens of New York; but they are all open to some criticism. The 1st prize design, illustrated by Fig. 1, is certainly artistic and effective as a standard for an electric light, but it would be difficult to make in cast iron with a proper finish, and the lighting of the street seems to be an altogether secondary consideration. These refuge points should be well lighted, and from this point of view the 3d prize design, Fig. 2, is far better, though as a standard for a light it is less ornamental in the street. The 2d prize design, not shown, is open to the objections that the isle itself would not be lighted at all, and the expanding of the post toward the lights gives a top-heavy appearance.

The Society is to be heartily commended for its effort to improve the appearance of our city and the city's streets, but something better still should be demanded of our artists and architects for these lampposts. We would recommend to these designers a close study of the late Brussels exhibit of street decoration, in the form of lampposts, hydrants, house and tavern signs, etc.

FRENCH LEGISLATION ON THE UTILIZATION OF WATER FOR POWER.

The Society of Political Economy of Paris has lately had presented before it an interesting paper upon the above subject written by M. Charles Pinat, a French engineer. An abstract follows from "Le Genie Civil" of March 29.

The question of water power, or "white coal" as some have termed it, is assuming great importance, especially in the portions of France bordering upon the Alps. Actual legislation upon this head, in France, rests entirely upon the distinction which is made between navigable and non-navigable streams. The first are part of the public domain through their entire navigable course, and the riparian owners have no rights of any kind in these waters. In this case the state is free, whenever it judges the conditions favorable, to authorize the use of this water for generating energy. But such authority is always revocable without indemnity to the utilizer. It is recognized, however, that this temporary authorization is anything but encouraging to the creation of great industrial establishments; and it is claimed that a general law should authorize the state to concede, under determined conditions, certain rights and profits to those who develop power from rivers of this class.

Upon non-navigable streams the case is entirely different. Articles 644,645 of the Civil Code, confirmed by the Law of April 8, 1898, recognize the special rights of the riparian owners to use the water. This right is as fixed as the rights of subsoil, alluvial accretion, accession, etc.; it properly belongs to the riparian owners and can not be interfered with by the administrative authority. The last is solely charged with the conservation and policing of non-navigable streams, including in this latter term, under the French law, "non-floatable streams," or those incapable of floating rafts of logs, etc. The justification of this law lies in the fact that the riparian owners alone suffer damage, as from overflow, etc.; and they pay for protection of the banks, even though this work be done and maintained at their expense by the state. The use of the water in the stream is the natural compensation for these charges.

But this right of using the waters, so as to establish any profit to the bank-owners, is as fatally parcelled out as the individual property in the banks. Unfortunately, the Civil Code was promulgated at the beginning of the last century, when water for motive power was only utilized by small branch canals, located often entirely within the property of one owner. To-day, to create one of the great water powers called for by modern industry, it is necessary to group the rights of water usage along a considerable length of the stream, and the difficulties multiply. The banks of the water course may be made up of inaccessible rocks, where we can with difficulty recognize any real property, and of which the delimitation is neither precise nor easy to fix; the deeds of transmission may exist, but in more or less confused and obscure form, and then the actual ownership of the banks is often a question.

These gaps in existing law, says M. Pinat, justify modifications which are already proposed. The French Parliament has before it two laws touching upon this subject; both of which imply for the state the right to concede the hydraulic power of water courses whenever these amount to 100 HP.—according to the government project, or 200 HP. as recommended by a Parliamentary commission. Industries founded under these laws would be classed as public industries; that is, they would be declared of public utility. This plan would not consider the navigable or non-navigable character of the stream; but only take into consideration the hydraulic power available. Below the figures named it would remain private property, and as such be ruled by the Civil Code and the law of 1898.

This creation of public hydraulic plants, by the

proposed laws of March 3, 1898, and July 6, 1900, is to effect a true expropriation, and puts into one hand the necessary concentration of the rights of riparian owners. These owners, under the law, would be indemnified when the declaration of public utility deprives them of water or hydraulic power which they were actually and effectively using; their prospective rights alone would be taken without compensation.

This direct interference by the state in the determination of interests of a private nature, says M. Pinat, seems to be abusive. There does not appear to be sufficient justification in the power of general regulation belonging inherently in the administration; since this power of regulating the rights of the riparian owners evidently does not carry with it the right to suppress them. The general necessity of reserving hydraulic energy for the general public service of transport, lighting, pumping of water, etc., for an immediate or near demand, is far from being demonstrated; neither, in a general way, is it the particular province of the state to utilize water courses, unless the private initiative is shown to be powerless in this respect. In the latter case more facilities are demanded from the state.

It should be added that this intervention by the state requires certain safeguards; a certain limitation in the duration of the concession; or in all cases the eventualities of redemption or of forfeiture.

As a means of adjusting the insufficiency of old laws and the unjust ruling of new projects of law, M. Pinat suggests a plan laid down in the works of L. Michoud. According to this proposition, any one would have the right to compel the sale by public auction of a certain portion of the banks of a water course. The portion to be sold would be indicated by the interests involved, the courts intervening only when these parties are unable to agree.

All agreeing to this adjudication, either riparian owners or others, give security that guarantees the payment of the price fixed by adjudication, and, in part at least, the indemnities that will have to be paid in the case. As soon as a definite right is established, the new owner must actually utilize the fall of water in as brief a time as possible, say in two months; and to conform also to the delays which would be imposed by the administration in the construction of works necessary for the utilization of the water power.

The price fixed by adjudication would be distributed between all the riparian owners; according as they had or had not made effective use of the right belonging to them, and also taking as a basis of compensation the height of the fall on each property. The damage, so far as other particular rights were concerned, would be adjusted by granting other land, sharing in the power developed, or by cash indemnity, as would be fixed by the civil tribunals.

This proposition would in no way interfere with the powers of regulation and police accorded to the administration by existing laws. On the contrary, the exercise of these powers would be facilitated by the fact that the rights of the third party would be regulated and already safeguarded by the power to sell at auction. On the other hand, the observance of administrative prescripts would be sanctioned in a very efficient manner, by the possibility of a demand for a new appraisement, if those acquiring the property do not conform absolutely to the regulations.

This proposition, in its essential terms, has the advantage of giving the same right to private interests as are now accorded to general interests, in taking for its basis the actual right of the individual.

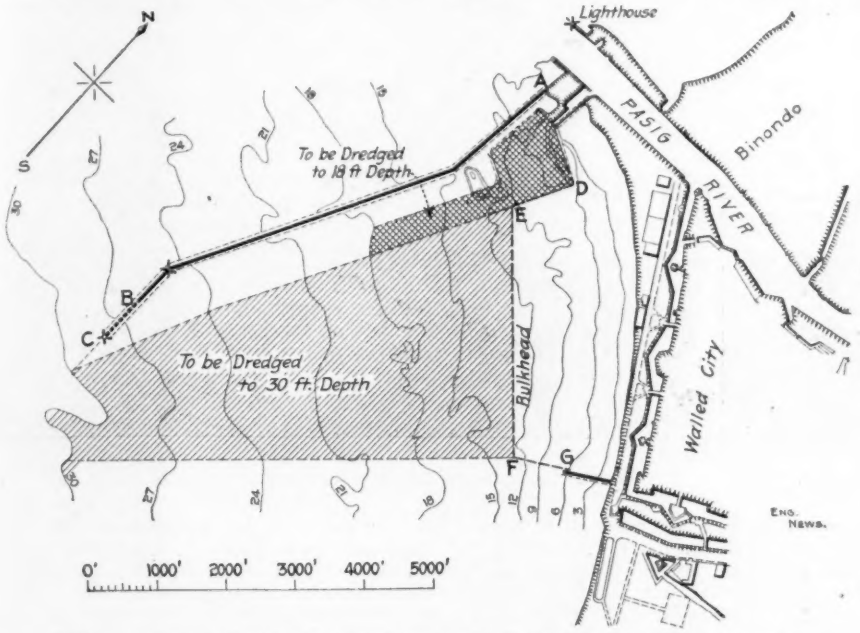

FIG. 1. MAP SHOWING GOVERNMENT IMPROVEMENTS OF MANILA HARBOR.
Atlantic, Gulf & Pacific Co., New York, Contractors.

THE U. S. GOVERNMENT HARBOR IMPROVEMENTS AND NAVAL COAL STORAGE PLANT AT MANILA.

The United States Government is now carrying out improvements at Manila Harbor which involve an aggregate expenditure of some $2,800,000. Of this sum about $2,000,000 are being expended in dredging the harbor to greater depth and constructing a bulkhead and breakwater. The remaining $800,000 are being spent in constructing a large coal storage plant for the U. S. Navy. The magnitude of this work, its location in our new Eastern territories, and the fact that it represents the best modern practice in engineering of this class, warrant its description in Engineering News. It should also be stated, before proceeding further, that the general contractors for the improvements are the Atlantic, Gulf & Pacific Co., of New York city, and that we are indebted to Mr. Geo. W. Catt, M. Am. Soc. C. E., and Mr. H. S. Wood, C. E., respectively, President and Engineer of this company, for the information from which our description has been prepared.

HARBOR IMPROVEMENTS.—The harbor improvements at Manila comprise: (1) the repair and extension of a breakwater which was originally begun and partly completed by the Spanish Government; (2) the excavation of the harbor bottom behind the breakwater to a depth of 30 ft., to provide room for the construction of piers, and for anchorage ground for vessels; (3) the building of a bulkhead and the depositing of the dredged material behind it to give increased land area immediately in front of the old part of Manila or the walled city. It is expected by the Manila Government that this new land will remunerate it partly at least for the expenditure in improving the harbor. Fig. 1 is a map of the proposed work. At present work is in progress on the breakwater and the bulkhead.

Referring to Fig. 1, it should be noted that the Spanish Government had constructed, previous to the American occupancy of the harbor, a breakwater along the line A B. The present contract includes the extension of this breakwater from B to C, the making of general repairs throughout its length, and the capping of a portion of the old structure with concrete blocks. According to the contract, the U. S. Government is to furnish the concrete capping blocks and the contractors are to put them in place on the breakwater. The area of harbor bottom to be dredged is shown by the hatched areas on the map, Fig. 1. The double-hatched area is to be dredged first in order to give as soon as possible moderately deep water in front of the back channel, giving entrance to the Pasig River. The single-hatched area comprising the larger portion of the work is to be dredged to a depth of 30 ft. All the dredged material is to be used for filling behind the bulkhead wall to be constructed along the line D, E, F, G. The construction of this bulkhead wall is shown by Fig. 2. It will be noted that the riprap in front of the front row of piles reaches to mean low water level. Figs. 3 and 4 are views of the bulkhead work in progress. Fig. 3 gives a very clear view of the bulkhead structure, of the pile-driver used, and of the character of the stone used for riprapping. Fig. 4 shows the portable crane used for depositing the riprap.

As already stated, the breakwater and bulkhead work is in progress. The stone used for this work is quarried at Mariveles, about 30 miles from Manila, on the left of the entrance to Manila Bay, and is towed to the work on barges. These barges have been built at a temporary shipyard established by the contractors in connection with a rather large plant of office buildings, machine shops, storehouses, etc. Fig. 5 is a view of a portion of this shipyard, with the pier extending to it from deep water, showing two of the barges on the ways. A general view of the buildings of the contractors' plant is given by Fig. 6. About the only indication of its unfamiliar geographical location are the two strange-looking native craft in the foreground of the picture. The dredging plant is now being constructed at Manila, and it is expected that dredging will begin during the latter part of this year.

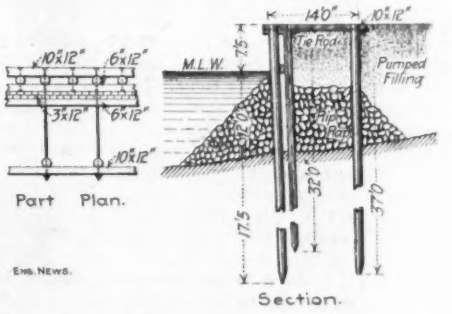

Fig. 2. Part Plan and Section of Bulkhead for Manila Harbor Work.

The quantities involved in the harbor work and the unit prices for the different classes of work are as follows:

Kind of work.	Quantity.	Unit price.
Riprap stone, breakwater	188,745 tons	$2.48
Concrete (all parts)	1,185 cu. yds.	15.00
Rubble masonry	14,396 " "	13.00
Coping	3,190 " "	40.00
Concrete blocks (placing only)	1,165 " "	9.00
Bulkhead (labor and bolts only)	4,700 lin. ft.	9.50
Dredging	5,000,000 cu. yds.	0.219
Riprap bulkhead stone	56,000 tons	1.75

These figures make the total cost of the work something over $2,000,000.

NAVAL COALING PLANT.—Five miles across the bay from Manila lies the Cavité peninsula, which was the scene of Dewey's victory. The town of Cavité is somewhat inward from the tip of the peninsula, and the extreme tip is called "Sangley Point." A rude coaling station has already been established by the Navy on this point, and a pile of coal on the ground with a simple temporary landing wharf are now there. The

urgent need of a better arrangement than this for coaling naval vessels prompted the Navy Bureau of Equipment to invite bids on Dec. 3, 1901, for constructing a modern fireproof coaling and storage plant at Sangley Point, with a storage capacity of 50,000 tons. By reason of limited appropriation, however, an alternate bid of the Atlantic, Gulf & Pacific Co. was accepted for a modified design, including coal sheds of one-half the original length, but retaining the entire steel wharf, and adding 2,500 tons of bunker storage in

FIG. 3. VIEW SHOWING PILE DRIVER AT WORK ON MANILA HARBOR BULKHEAD.

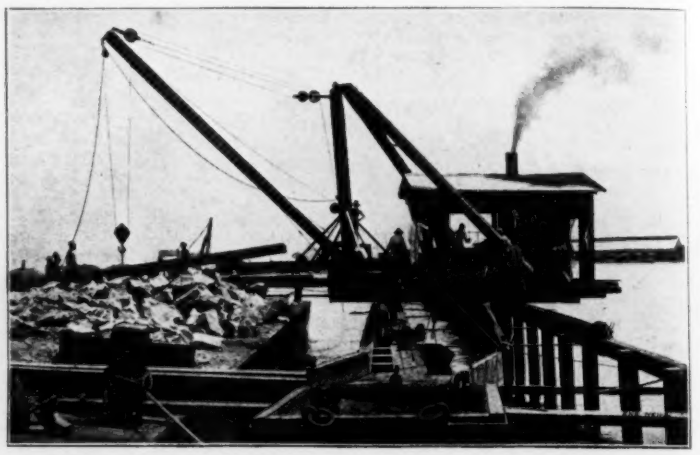

FIG. 4. VIEW SHOWING RIP-RAPPING IN PROGRESS ON MANILA HARBOR BULKHEAD.

the steel trestle on the landing wharf. Future extension of the two coal sheds can readily be made to obtain the originally intended capacity, but the capacity of the plant now being built is limited to about 25,000 tons. The design of the station contains no startling innovations, but comprises the most recent improvements in general arrangement, and admits of all reasonable alternate movements of the coal from ships to storage and from storage to ships.

In general it has been found highly advisable to store Navy coal on a somewhat elevated floor, and to draw from said storage by gravity through the valves in the floor so that ordinary ground tracks passing underneath these valves will permit of the loading of small dump cars by merely opening the floor valves, then running the cars down a slight grade to the point of wharf delivery without other mechanism than one man attendant. To get the coal into the sheds from the supplying colliers, however, the highest type of automatic machinery is used, and all such apparatus, as well as the automatic elevated delivery railways, and the entire system of tracks, and scales, and cars on the ground, have been furnished by the C. W. Hunt Co., of New York city, as subcontractors to the Atlantic, Gulf & Pacific Co.

One special feature in the structural design is the use of cast-iron cylinder "Cushing piers," spaced 24 ft. c. to c. lengthwise of the wharf, and 30 ft. c. to c. transverse thereto, as the principal wharf foundations and supports of the heavy steel bunker trestle, which in turn forms a runway for the two traveling steeple coal hoist towers. The actual support of the wharf surface and bunker is provided by these cylinder piers, and the heavy box cap girders resting on them, and anchored to the concrete sea wall, because it will be observed that these cap girders cantilever 13 ft. outboard of the front cylinders and are strong enough to support all superimposed weights to the very front of the wharf, and also to withstand all mooring shocks. The slender iron piles with creosoted wooden fenders in front, which form the front face of the wharf, have practically no vertical load to sustain, and merely form a fender curtain and a foundation for diagonal bracing to stiffen the front of the wharf against mooring strains.

Referring to the illustrations: Fig. 7 is a general foundation plan of the plant now being constructed for storing 25,000 tons of coal. To increase its capacity to 50,000 tons the inshore depth of the building merely needs to be doubled. Fig. 8 is a part front elevation and part plan of the wharf on which the sheds front, and Fig. 9 is a transverse sectional elevation of the wharf, wharf bunker and the coal hoist towers. Fig. 10 is a cross-section of one-half of one coal shed, indicating the structural framing adopted.

In receiving coal from vessels for storage the operation of the plant will be as follows: A collier or lighter bringing coal for storage is moored to the wharf and unloaded by an automatic clam shell bucket or shovel operated from either traveling tower and discharging into a 15-ton hopper in the engine house in the tower. This hopper is periodically discharged into an automatic car in a story of the tower below the engine room and on a level with one of the twelve automatic railways leading backward on a slight down grade into one of the six monitors of the two coal sheds. This car serves any one of the twelve tracks at choice by fleeting the tower along the bunker by hand-winch and stopping it at the right connecting point. Flexible steam pipe connections are instantly made with the tower engines, and while one tower will ordinarily be used to serve one shed, there is no difficulty in using both towers for one shed.

The moment the coal drops from the tower hopper into the automatic car it is automatically weighed and the weight is recorded. The car is then despatched into the shed monitor by gravity. A cross-bar lying on the track at any pre-arranged point is picked up by the automatic car, thus engaging the restraining effect of a triangular counterweight hung under the bridge spans, and permitting the coal to be dumped at any desired point of the track. Instantly after this dumping the triangular counterweight under the bridge spans, which has been lifted by the momentum of the car on the descending track, begins to pull the car back up the grade towards the steeple tower, and when the car has returned to the point where it picked up the counterweight connection it has been given sufficient impetus to deliver it to its starting point on the lower floor of the traveling tower ready for the next load.

In order to minimize the breakage of coal and distribute the falling coal within the limits desired on the floor of the shed, a traveling double deflection board is used and supported by trolleys rolling on the eye-beams shown in Fig. 10 underneath the tracks in the monitors. These deflection boards can be slung out to any desired angle, and can be located at any point lengthwise of the monitor.

If, instead of storing the coal in the sheds, it be desired to fill the wharf bunker, the same operative steps are arranged as above described, down to the point where the coal is deposited in the automatic car and automatically weighed. The car is then run by hand a few feet off the scales and dumped through apertures in the floors of the traveling tower directly into the wharf bunker, and returned by hand to its position on the scale and under the hopper.

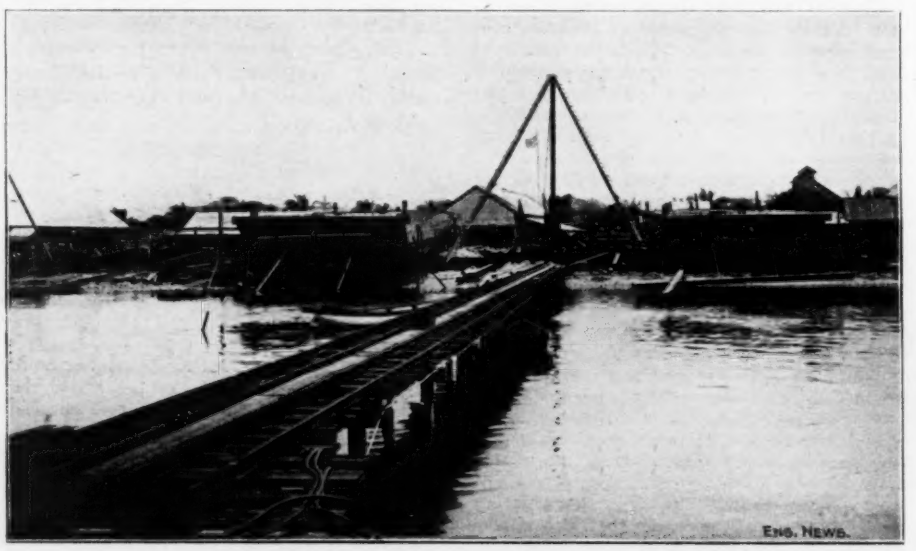

FIG. 5. VIEW OF CONTRACTORS' SHIP-YARD AND PIER, MANILA HARBOR IMPROVEMENT.

There are several available methods for delivering the stored coal to vessels. These may be summarized as follows: (1) Coal is delivered from the wharf bunker to vessel or lighter by lowering the outboard bunker chutes to the position shown in Fig. 10, and discharging the coal outboard by gravity. (2) Coal is discharged from the shed to vessel or lighter by running tip cars through the tunnels under the shed floors to a chosen floor valve, filling the car from this floor valve, and

running the car by hand down grade out to the wharf, passing over track scales on the way and arriving at the track parallel to the front of the wharf, and close to the guard rail. The coal is then dumped sidewise over the guard rail directly into the lighter. For vessels containing hoisting apparatus and a height and width of deck making impossible such gravity delivery the dump car is replaced by a flat car containing coal tubs, and these are in turn filled from the floor valves of the main sheds and run out to the front wharf, as described above. The coal tubs can then be picked up by the hoisting rig on the lighter or ship and delivered into any hatch or pile desired

The plans do not show such details as exact location of two creosoted nineteen-pile dolphins in front of the wharf, or of the heavy cast-iron mooring bitts on the front line of the wharf, or the "brows" or movable gangways and spur shores or struts which serve to hold and give access to any vessel lying alongside. These details are separate matters and subject to change of location.

The only unusual construction aside from the wharf foundation of heavy cylinder piers will be found in the re-enforcing of the 6-in. concrete floor slabs on 4-ft. spans in the main coal sheds with electrically-welded galvanized wire netting

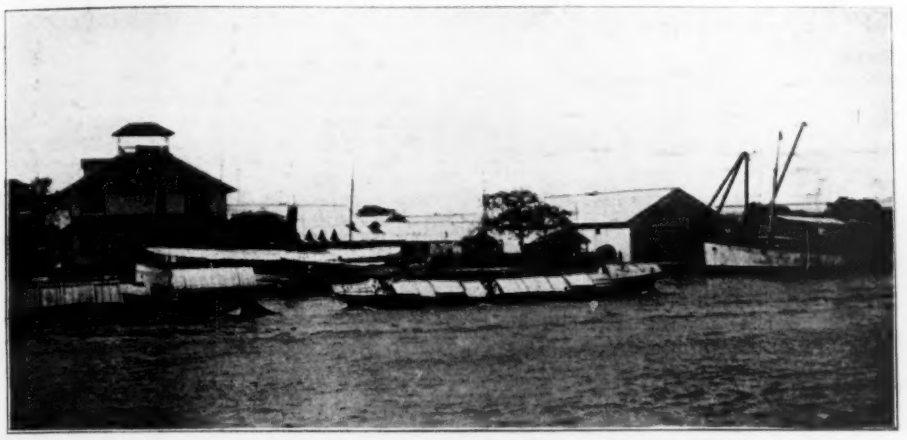

FIG. 6. GENERAL VIEW OF CONTRACTORS' PLANT AND BUILDINGS, MANILA HARBOR IMPROVEMENT.

on board the craft. It will be observed also that instead of these tubs being lifted by hoisting apparatus on the vessel there will be no difficulty in having the traveling tower hoist pick up the same tubs and deliver their contents into the wharf bunker, so that the immediately deliverable stock in the wharf bunker can be renewed from time to time from the sheds. (3) Frequently coal must be delivered to vessels in bags, and special cars containing bags, with light frames to hold them while loading, are provided to run underneath the valves in the shed floor and thence to the front of the wharf for delivery outboard; or else they can be filled from the bunker by small and nearly vertical bagging chutes located midway of the wharf bunker.

If by any chance all of the methods of delivering coal above described should prove insufficient, the side doors of the sheds are opened and the bags are filled by hand on the floors inside of the sheds and delivered by carriers passing down the inclined planes to the wharf level.

As indicated above, there are two coal sheds, each 145½ ft. long transverse to the sea wall, and 193½ ft. wide parallel to the sea wall, and separated by a gangway of 46½ ft. At the front of this gangway is located a small power house 21½ ft. by 50 ft., containing two 100-HP. locomotive boilers, a large fire pump, and a small tank pump, with room for a future electric light plant. The boiler room is open on three sides. Immediately back of the power house a double tank tower of steel supports, at an altitude of 60 ft., two steel tanks of 25,000 gallons capacity each.

The steel wharf is 75 ft. wide by 435 ft. maximum length, supported mainly by the sea wall and 36 cylinder piers, as shown in Figs. 8 and 9. Each cylinder pier contains seven Oregon pine piles, 60 ft. long, driven and followed down to the position shown in Fig. 9. The sea wall is supported by similar piles, and the pedestals under the sheds have from four to eight piles under them, depending on the vertical loading. The wharf bunker is 30 ft. wide by 360 ft. long, and will contain about seven tons of coal per lineal foot. The structural framing is entirely of steel, and the lining of the bunker is of 3-in. Oregon pine plank with battens over the floor joints. The traveling towers are about 75 ft. high above the top of the bunkers, and the hinged horizontal boom reaches 40 ft. beyond the face of the wharf, or about 55 ft. beyond its supports on the front legs of the tower.

in place of expanded metal of the usual type which was originally specified. It was proposed by the contractor to substitute this material, made as strong as it could be, for the same market price per square foot as the specified expanded metal. Actual tests to destruction were then made under the auspices of the Bureau of Equipment on full-size floor slabs, and the welded wire fabric proved superior in ultimate strength. As this fabric can be obtained in sheets at least 8 ft. wide, by an indefinite length without splices, and as the expanded metal is only obtainable in sheets 6 ft. by 8 ft., the contractor has been able to fit the conditions of the coal floor much better by the substitution, and, in addition, to secure increased strength of the floor.

parts cement mortar. The stone for the concrete will come from the contractors' Mariveles quarries, which are supplying the main Manila Harbor contract, and is a first-class quartsite or andesite, looking very much like a soft granite or very hard sandstone, and working very well in a crusher.

The galvanized corrugated iron covering for roofs and walls of the sheds is No. 20 gage, with 9-in. end laps and two corrugation side laps, and riveted straps around every purlin not more than 10½ ins. apart on the average. The corrugations are 3 ins. wide. The small power house is not enclosed or covered by corrugated iron, but is made of a skeleton frame of steel embedded in concrete.

About one-half of the material for this contract has been already shipped to Manila on the government collier "Ajax," and the remainder will go in about 60 days. The work will be completed about August, 1903.

The quantities and contract prices for the work described are as follows:

Contract price	$554,310
No. of 60-ft. Oregon pine piles untreated	3,120
No. of 50 and 60-ft. creosoted eastern pine piles	116
Creosoted wharf fender wailings	14,000 ft. B.M.
Plain Oregon pine lumber	208,600 " "
Foundation and floor concrete	7,245.6 cu. yds.
Filling and grading	25,000 " "
Dredging	40,000 " "
Cast iron	650 tons.
Ordinary structural steel	2,510 tons.
Galvanized iron and steel	190 "
Value of coal, machinery, tracks, cars, etc.	$100,000
Value, power house, boilers, engines, steam, piping	$11,000
No. of double traveling deflection boards in monitors	6
No. of automatic temperature tubes with thermostats in sheds	84

The usual and necessary trimmings, such as monitor glass, ventilating, louvres, lifting sections of galvanized wall covering for ventilation, hardware, drains, cast-iron drainage pipe, house plumbing, etc., are included.

The main contractors for the above work, as before stated, are the Atlantic, Gulf & Pacific Co., of Park Row Building, New York city. The original plans and specifications were prepared by the Navy Bureau of Equipment, under the direction of Admiral R. B. Bradford, Chief of Bureau.

A RAPID PROCESS FOR THE CHEMICAL ANALYSIS OF WATER.

Dr. Pignet and Mr. Edouard Hue, a French druggist, have devised a rapid method of examining drinking water, with special reference to its use by marching troops. As described in "Le Genie Civil," for July 12, 1902, Messrs. Pignet and Hue

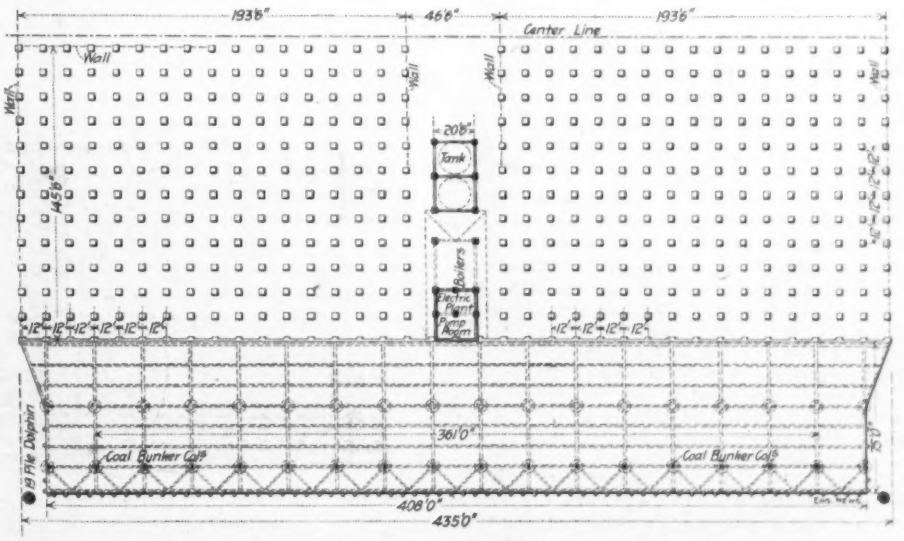

FIG. 7. GENERAL FOUNDATION PLAN OF NAVAL COALING STATION AT MANILA.

The shed floors are concrete slabs 6 ins. thick, of which 5 ins. will be 1-2 1/2-5 concrete, and the top 1 in. of granolithic mixture. The cylinder piers are filled with concrete of 1-2 1/2-5 mixture. The sea wall is of 1-2-4 mixture. The inland shed foundation pedestals are 1-3-6 mixture, with a granolithic top finish. The hollow cast-iron piles on the wharf front have each 2, 30-lb. rails built into them, embedded in a one part sand and five

have selected two of the chemical characteristics of water as being sufficient for the purposes of these tests; the presence of nitrites, generally implying a bad bacteriological composition, and the presence of nitrates, which in excess denote certain contamination. By using compressed tablets of chemicals, instead of solutions, the quality of the water can be ascertained in ten minutes. The method is as follows:

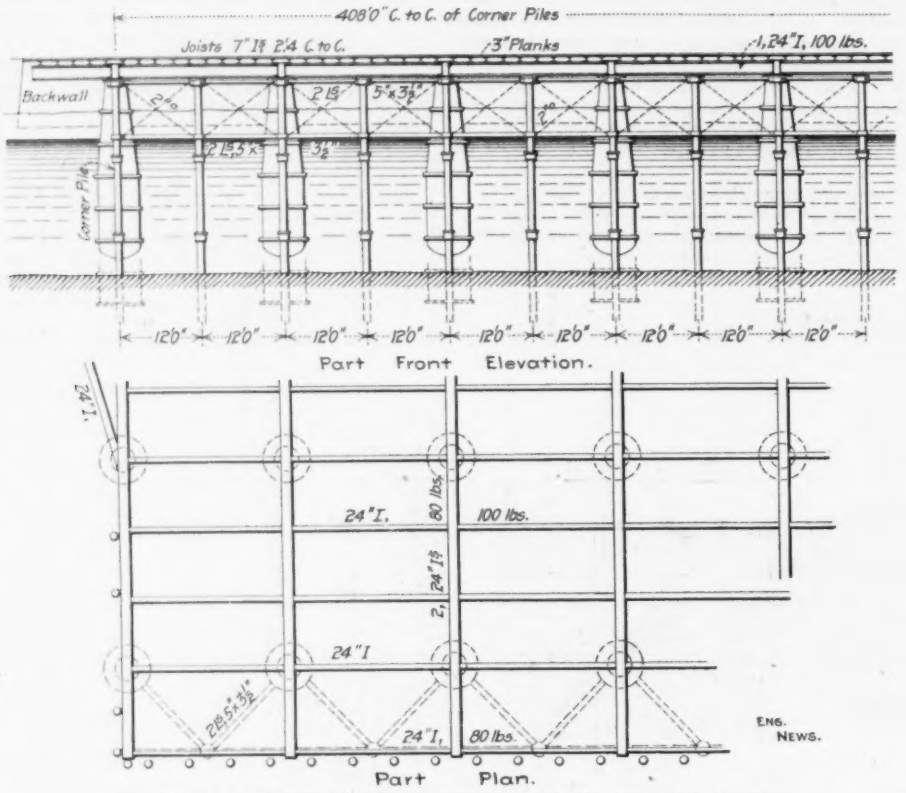

FIG. 8. ELEVATION AND PLAN OF COALING STATION WHARF.

To test for nitrites or azolites, put into a glass 110 cu. cm. of the water to be tested; add to this a compressed tablet of ioduret and let it dissolve. When this is well dissolved add an acid tablet, crush and dissolve, and the result will be: (1) If the liquid remains colorless after five minutes, the water does not contain nitrites. (2) If the solution develops a blue color, more or less rapidly in this five minutes, the water contains nitrites; the rapidity with which the blue tint appears and the intensity of the color measure the proportion of nitrites contained in the water.

If the blue tint appears immediately, or at the moment the acid tablet is crushed, and the solution shows a pronounced blue at the end of two minutes, it is safe to assume that the water contains 2 milligrammes of nitrites per liter. If the blue tint appears at once and shows a deep blue at the end of five minutes, the quantity is about 1 milligramme per liter. A less rapid and less intense discoloration indicates a less proportion of nitrites. Very light traces of nitrites will cause discoloration within five minutes. If the water contains nitrites it is bad, and it is useless to search for other characteristics.

But if the water remains colorless, a tablet of zinc should be dissolved in another measure of it to test for nitrates. If the water still remains colorless it contains no nitrates, but if the solution becomes blue at the end of five minutes it does contain nitrates. If the blue tint appears at the end of two or three minutes, and is still feeble in color at the end of five minutes, the water contains from 10 to 20 milligrammes of azotates per liter, and it can be used. On the contrary, if the blue tint appears at once and becomes a deep blue in five minutes, the water is bad, or at least very suspicious.

To make these ten-minute water tests, the necessary apparatus includes a glass of a capacity of 125 cu. cm., a stirring and crushing rod, and three little bottles holding the tablets mentioned. The three bottles will go into the glass, and the bulk and weight are so small that the whole outfit can be carried in the pocket. When time permits the analysis can be completed in an hour, and the free and albuminoid ammonia, chlorides, organic matter, etc., be ascertained by the use of tablets especially adapted for each test. The authors of the process, however, do not describe the method of preparing these tablets, which seem to be so prepared solely for the purpose of reducing the outfit to a minimum bulk.

MOSQUITO EXTERMINATION in some of the outlying districts of New York is to be continued by the health department, under the direction of Mr. Geo. A. Soper, Assoc. M. Am. Soc. C. E., 29 Broadway, New York city, and others. Draining and filling in low places will be given particular attention.

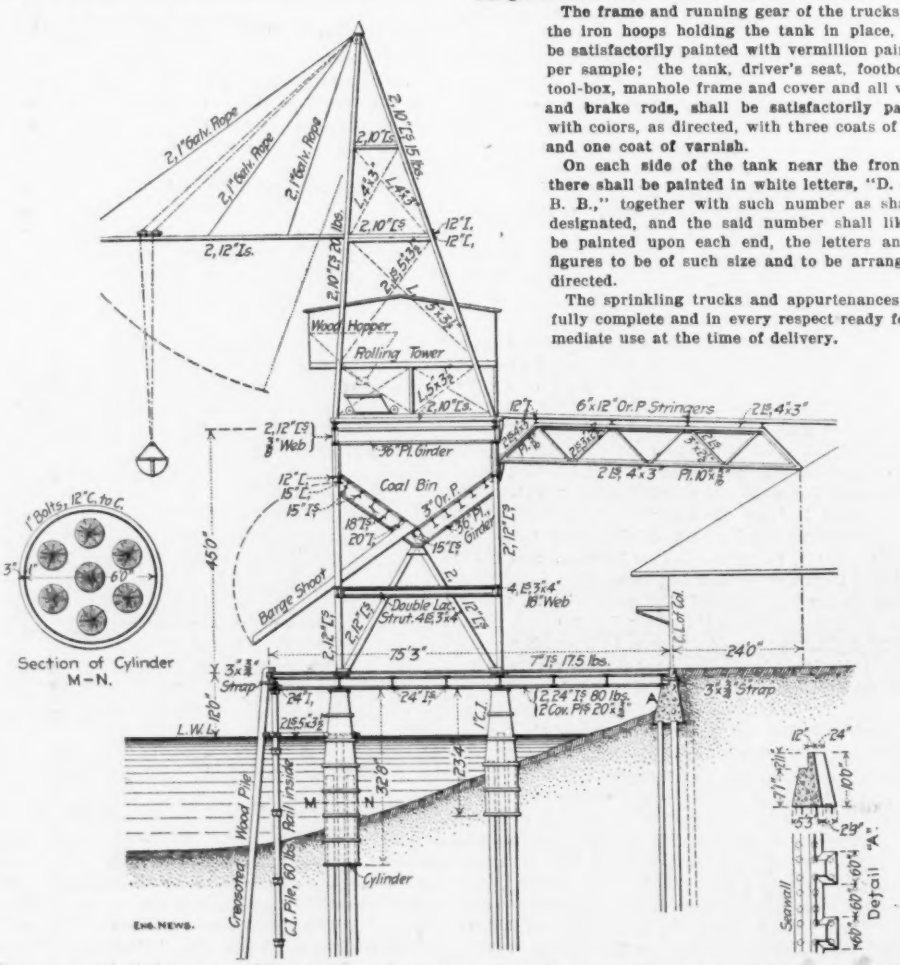

FIG. 9. SECTIONAL ELEVATION OF COALING STATION WHARF, WHARF BUNKERS AND COAL HOIST TOWERS.

SPECIFICATIONS FOR STREET SPRINKLING TRUCKS, NEW YORK DEPARTMENT OF STREET CLEANING.

At the recommendation of Mr. John [illegible] Woodbury, Commissioner of Street Cleaning of the City of New York, the following specifications for 19 street sprinkling trucks or wagons, for use in the borough of Brooklyn, were recently adopted by the Board of Estimate and Apportionment.

The sprinkling trucks furnished under this contract shall be of the latest improved type, with platform spring [illegible] fitted with shafts and all appurtenances complete, and equipped with brakes of a power sufficient to hold the loaded truck to a standstill on a 10% grade.

The truck to be fitted with the best Concord steel axles and oil-tempered steel springs and to have Archibald patent wheels or other equally good wheels, with tires 3 ins. wide.

The barrel or tank to be of the best quality white pine clear stock, to be perfectly watertight and to be of a capacity of 300 gallons, the tank to be firmly attached to the truck frame with not less than six adjustable iron hoops and to be fitted with suitable cast-iron manhole cover and frame, having a swivel gooseneck connection for attaching filling hose.

A filling hose 12½ ft. in length to be provided with each sprinkling truck, said hose to be of the best quality four-ply rubber hose of 2½ ins. interior diameter, fitted with a standard coupling "female" of brass 2½ ins. interior diameter, the hose to be attached to the gooseneck connection ready for use, and two iron hooks for holding hose when not in use to be attached to the truck, as will be directed.

At the front end of the tank there shall be a suitable driver's seat on springs and a suitable footboard; a suitable footboard also on each side of front end of tank; also suitable tool-box, with lock and duplicate keys at the front end of tank, to contain hydrant wrench and hose spanner; one of each of the said tools shall be furnished with each truck, the hydrant wrench to be of the combined pattern now in use in the Department in the Borough of Brooklyn.

The sprinkling valves to be made of the latest improved pattern, rear sprinkling tips discharging the water through an adjustable slot so arranged as to force the water from the valves at an angle inclined above a horizontal plane, permitting the water to fall upon the roadway and not forcing it directly thereon; the volume of water discharged must be under control from the driver's seat.

The frame and running gear of the trucks, also the iron hoops holding the tank in place, shall be satisfactorily painted with vermillion paint, as per sample; the tank, driver's seat, footboards, tool-box, manhole frame and cover and all valves and brake rods, shall be satisfactorily painted with colors, as directed, with three coats of paint and one coat of varnish.

On each side of the tank near the front end there shall be painted in white letters, "D. S. C., B. B.," together with such number as shall be designated, and the said number shall likewise be painted upon each end, the letters and the figures to be of such size and to be arranged as directed.

The sprinkling trucks and appurtenances to be fully complete and in every respect ready for immediate use at the time of delivery.

All the materials used to be first-class and thoroughly seasoned and to be of the best quality of their respective kind, and the workmanship to be first-class in every particular.

[illegible]—Running gear and sprinkling valves other than those described above may, at the discretion of the Commissioner, be submitted, providing such running gear and valves are equivalent or superior to those which would fulfil the strict wording of the above specifications.

A sample truck or photograph of the same, which it is required to furnish, must be submitted to the Commissioner.

The lowest bid under these specifications, as stated in the Supplement of our issue of July 31, was $197.50 per truck.

STEEL-CONCRETE CULVERTS AT MOBILE, ALA.

By J. N. Hazlehurst,* M. Am. Soc. C. E.

Some steel-concrete culverts have recently been built at Mobile, Ala., as a substitute for the usual concrete bottom, brick side walls and iron cover plates. As a covering for the culverts use has been made of the 6-in. concrete foundation of an asphalt street, combined with expanded metal. The design, so far as I am aware, is new.

The problem was to pass storm water across the intersection of a street being paved with asphalt and one that was unimproved, and provided only with surface side gutters, where underlying water, gas and other pipes prevented the introduction of crossing pipes with necessary areas equivalent to 9 ft.

Flat-Topped Concrete Steel Culvert Under Construction at Mobile, Ala.

On each side of the unimproved street and at right angles to the proposed asphalt work, along each side gutter, there was set parallel lines of 4 × 20-in. rejected granite curbing in lengths of not less than 6 ft. These stones formed the sides of the culverts. The bottom was formed with 4 ins. of concrete floated to a smooth surface. Each culvert was 4½ ft. wide, 12 ins. high and 50 ft. long, without the cover. A view of the culvert under construction is shown by the accompanying illustration.

As soon as the bottom was sufficiently dry, a center or form of 4 × 4-in. timbers and 2-in. planks was set up loosely and covered with tarred paper extending beyond the sides of the walls of the culvert. Over the paper was spread 1 in. of gravel concrete, and upon this was laid and bedded sections of 3-in. No. 10 expanded metal; over this was spread the 5 ins. additional of stone concrete, composed of 1 part cement, 4 sand and 6 parts broken stone. This strip of concrete was laid in advance of the regular work, but conformed in cross-section and grade to the concrete for the regular street foundations. After setting about a week, the regular work of concreting having reached this crossing, a bond was made and the foundation for this intersection fully completed, being followed by a 2-in. wearing surface of asphalt. A steam roller weighing approximately 300 lbs. per in. was drawn and stood upon the concrete slab of 4½-ft. flat span. Subsequently the street was thrown open to traffic, and the construction described is in every way satisfactory and permanent.

Where the side ditches of the unimproved streets joined the steel-concrete culverts, catch-basins or silt-boxes of masonry and iron gratings were installed.

The cost of each culvert approximated $200.

*Chief Engineer, Department of Engineering, Board of Public Works, Mobile, Ala.

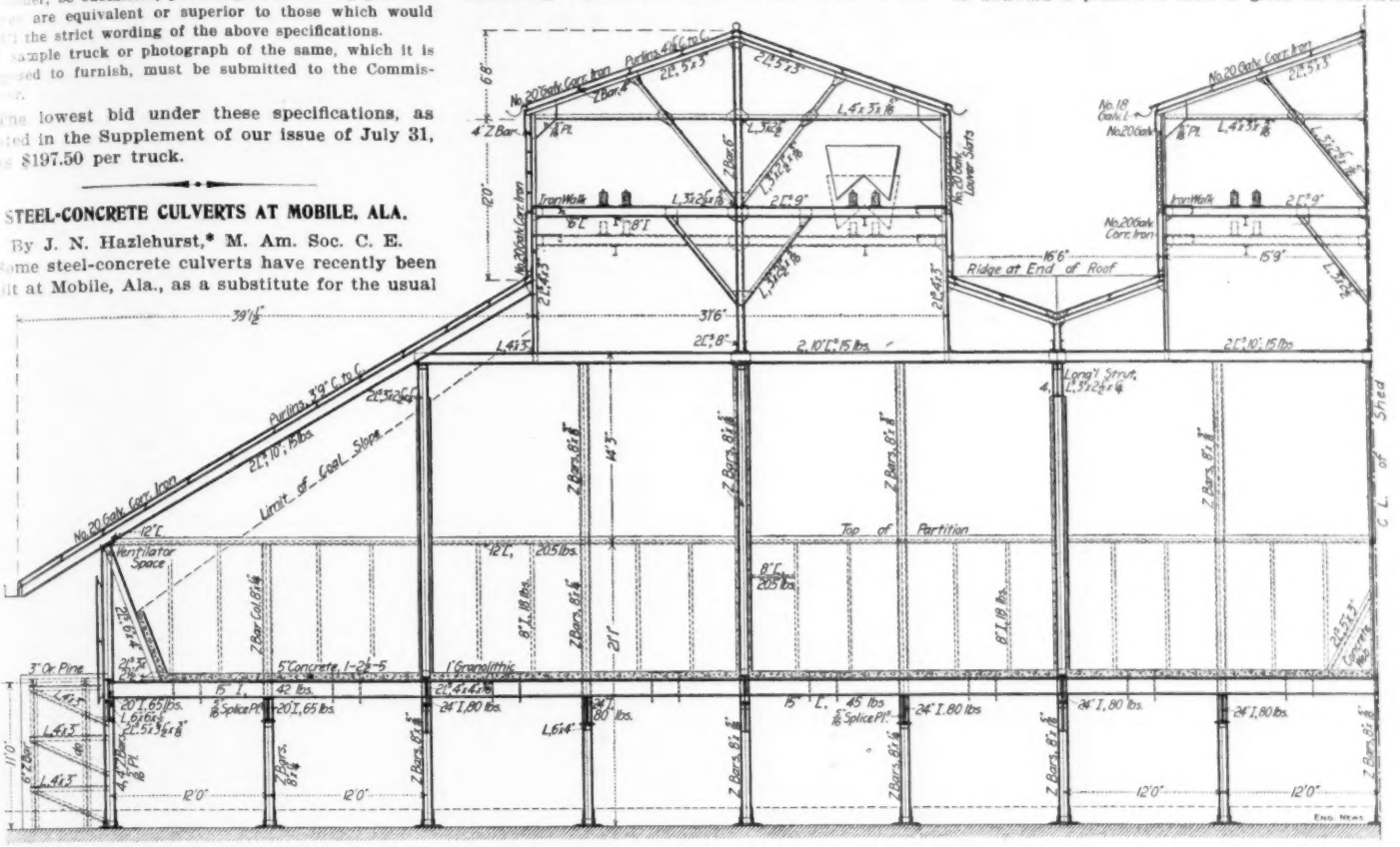

FIG. 10. HALF TRANVERSE SECTION OF COAL STORAGE SHEDS.

BOOK REVIEWS.

SEWAGE WORKS ANALYSES.—By Gilbert J. Fowler, Superintendent and Chemist, Manchester Corporation Sewage Works. New York: John Wiley & Sons. London: P. S. King & Son. Cloth; 5 × 7½ ins.; pp. 135; tables and illustrations. $2.

The author of this book has become well known to students of sewage purification through his work, experimental and practical, in connection with sewage disposal at Manchester, England. The opening chapter of the volume, entitled "The Chemical Control of Sewage Purification Processes," will be of value to any one having occasion to design or operate sewage disposal works, or to familiarize themselves with the general subject. The book as a whole, we should think, will be welcomed by all who are making sewage analyses, particularly as it, so far as we know, is the only book devoted exclusively to the subject. After taking up determinations of oxygen, ammonia, nitrites and the like, the author devotes a chapter to "The Analysis of Gas from the Septic Tanks and from Filter Beds." It is a pity, which the author recognizes, that grains per imperial gallon, instead of parts per 100,000 or per 1,000,000, should be employed in such a work. The author felt constrained to do so, however, to meet the wants of British readers, for whom the book was primarily written. To make some amends for so awkward a practice a table is given for converting grains per gallon to parts 100,000. The book also contains several other useful tables.

THE INTERNATIONAL YEAR BOOK.—A Compendium of the World's Progress During the Year 1901. Frank Moore Colby, M. A., Editor. New York: Dodd, Mead & Co. Cloth; 8 × 10 ins.; pp. 900; tables and 47 illustrations. $3.

The present issue of this useful work of reference is fully up to the standard, and in some respects superior to the earlier ones. Among the contributors may be mentioned Dr. A. C. True, of the U. S. Department of Agriculture, who writes on agriculture, forestry, crops and irrigation; Prof. Heinrich Ries, of Cornell, who contributed articles on geology and mineral production; and Messrs. M. N. Baker and C. S. Hill, of the editorial staff of this journal, to whom were assigned, as heretofore, engineering and allied topics.

CITY ROADS AND PAVEMENTS SUITED TO CITIES OF MODERATE SIZE.—Second Edition, Revised and Enlarged. By William Pierson Judson, M. Am. Soc. C. E., M. Inst. C. E. New York: The Engineering News Publishing Co. Cloth; 6 × 9 ins.; pp. 195; tables and illustrations. $2.

The local features of the first edition of this book, which was a report to guide the city officials of Utica, N. Y., have been omitted, and new and later matter has been added to correspond with its title. Some interesting historical matter on early stone wheel tracks in America is included, illustrated by recent views. There are also new tables for determining standard crowns, giving the cost of asphalt pavements in 1900, grades and costs of different kinds of pavements and other valuable information of like character. Besides the discussion of broken stone roads, special mention may be made of the chapter on "Concrete Base for Pavement," which takes up cement tests in some detail and goes into the various phases of mixing and laying the concrete. The illustrations include a number of fine half-tone views of roads and pavements, both under construction and completed, many of which were reproduced from photographs taken during the past two years.

A SPECIAL COURSE in Army and Naval Ordnance is being established at the Massachusetts Institute of Technology, for the use of graduates from West Point and Annapolis. This course deals with the design and manufacture of large guns. A special course in naval architecture was established at the Institute three years ago, solely for government students; the course in ordnance will be ready about February, 1903.

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In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 322 means that subscription is paid to the 32d week (that is the issue of Aug. 7) of the year 1902; the change of these figures is the only receipt, unless one is sent by special request.

ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

Such private water companies as lack municipal authority to install meters without the consent of water consumers might find it worth while to try the plan recently proposed by the new management of the Birmingham (Ala.) Water-Works Co. That company has just offered, for the privilege of installing meters at will, to reduce the scale of meter charges from the present range of 30 to 8 cts. per 1,000 gallons to a new schedule of 20 to 6 cts. The company also offers to place 105 additional fire hydrants without charge to the city, and to install further hydrants, in addition to the 105, at $40 each, instead of $55, per annum.

The report that the city of Trenton, N. J., proposes to engage a competent engineer to report on the new garbage crematory, regarding which nearby residents are complaining so bitterly, raises the question, why was not an engineer employed at the outset? If we remember rightly, the selection and installation of the furnace in question was entrusted to the police committee of the city council, and the plant was built under a loosely-drawn contract. Had the city consulted an experienced engineer at the beginning, there is reason to believe that better sanitary and economic results would have followed.

The selection of a firm of expert accountants to work with a board of engineers in studying the water supply problem at Memphis, Tenn., is a commendable action on the part of the city. (For particulars, see Eng. News, July 17, p. 41.) The accountants, of course, will consider questions of cost of construction and service, chiefly under the present system of private ownership. The value of expert services is gradually being recognized by municipal authorities, but it would be well for the country at large if the recognition were more rapid and widespread.

THE GARBAGE DISPOSAL PROBLEM IN BOSTON AND ELSEWHERE.

The city of Boston has not handled its garbage disposal problem with the same intelligence and success as it has shown in dealing with other sanitary problems, or else its Board of Health is sadly mistaken or badly prejudiced. The situation is partly explained by the following quotation from the report of the board for the year 1901:

GARBAGE PLANT.

This plant is situated at Cow Pasture on Dorchester Bay; is the property of the New England Sanitary Product Co., and is constructed and operated on what is known as the reduction method. It was put in operation November, 1898, was soon complained of by the people living within a radius of more than two miles, was carefully investigated by the Board of Health and declared to be a public nuisance. The same experience and declaration were repeated in 1901. All effort on the part of the Board of Health to secure action of any kind against the New England Sanitary Product Co., either under its contract with the city or on the merits of the case in court, have been negatived by the city government, and the powers of the Board of Health to fight this public nuisance, for the time being, have been made void. This plant has been a well-known public nuisance from the time it was put into use to the present day, and has thus far appeared to defy all efforts of the said company to stop the nuisance, which appears to be the result of an inherent power for offence in the reduction process, of which this plant is an example. The plant is now to be removed from its present location, where it is so bitterly complained of, to another on Spectacle Island, where it will be placed between and within a few hundred feet of two other very offensive plants, one for rendering dead animals, bones, grease, etc., and the other for the manufacture of glue.

Its new location is also within a few hundred feet of the main ship channel, through which millions of persons pass to and from the city every season.

Ten years ago the subject of garbage disposal in Boston was investigated by Mr. H. H. Carter, M. Am. Soc. C. E., as set forth in his annual report, as superintendent of streets, for 1892 and 1893. Mr. Carter recommended that dumping at sea be continued for sections tributary to the dumping wharves then in use, but that a garbage reduction plant be established for the central district of the city and that three crematories be built in as many outlying districts yielding relatively slight quantities of garbage. The avoidance of long hauls was one of the objects of the plan outlined. Meanwhile a "Joint Special Committee on the Disposal of City Offal," consisting of members of both branches of the city council, visited a number of garbage disposal works, held public hearings and published a report (City Doc. 91, 1893). The report contained no recommendations, further than that a change from present methods of disposal was desirable and that the superintendent of streets be requested to report on the subject, which he subsequently did in 1893, as already stated.

In 1894, the city council, instead of arranging for the plant of say 150 tons capacity, recommended by Mr. Carter, contracted for a 20-ton plant, to be located in the Dorchester section of the city, on land rented by the street department from the school commissioners. The contract provided that the plant should be removed and the contract terminated if the plant should at any time be declared by the Board of Health to be a menace to health or a nuisance to the neighborhood in which it was located. The contractor was the New England Construction Co., a licensee of the Sanitary Product Co., of Philadelphia, which also controls the main patents involved in the present Boston, New York and Philadelphia plants.

On Jan. 21, 1895, the first Boston plant was put in operation, but in a few weeks the Board of Health declared it a nuisance, and cancelled its permit for the location of the plant. In April the board brought suit in the State Supreme Court for an injunction against the operation of the works. This was granted, and, without appealing to the full bench, the contractor shut down the works on April 18. In justice to the contractor it should be remarked that there was little object in running a 20-ton reduction plant, except as a step towards securing a larger contract.

In November, 1897, bids for garbage disposal by cremation or reduction were invited, and soon a ten-year contract for disposal by reduction was awarded, the plant to be located on land furnished by the city. The original call for bids named Spectacle Island (in Boston Harbor) as the site, but the works were built on the water front, adjacent to the Calf Pasture sewage pumping station, in the Dorchester section of the city. The contractors were organized as the New England Sanitary Product Co., but both the interests and the patents involved were much the same as before.

The second plant was put in operation on Nov. 15, 1898, but was damaged by fire in February, 1899. On June 21, 1899, the Boston "Herald" stated that complaints against the works continue to be received at City Hall." Agitation by individuals and associations was continued during the summer, and on Aug. 22 the Board of Health addressed a letter to the Mayor declaring the works " 'objectionable to the public health or comfort' within the meaning of the terms of the contract," and virtually recommending that the contract be cancelled. But while the contract recognized the Board of Health it did not, like the earlier one, give the board any initiative in steps for its cancellation. Instead, it provided that, barring unavoidable causes, if for five successive days the garbage was not removed and treated "as required in this contract" the superintendent of streets, with the approval of the Board of Health and of the Mayor, might cancel it.

Notwithstanding the fact that the report was submitted at the very height of the popular agitation against the disposal works, the Mayor did not make it public until it was actually or virtually demanded by the Board of Aldermen. On Oct. 30 the Mayor transmitted the report, with a letter in which he stated that a few days after the report was received he, together with the superintendent of streets and the city engineer, visited the reduction works, and that the two former had concluded that no radical steps were necessary. They believed that the odors complained of were chiefly due to the raw garbage on the scows arriving at the works, and to the tankage being temporarily shipped from the works without being dried. Arrangements had been made to disinfect the raw garbage, and the trouble from tankage, it was expected, would cease as soon as the damages due to fire had been made good. After much discussion in the Board of Aldermen an order was passed instructing the Board of Health and City Solicitor to begin proceedings to compel the company to abate the alleged nuisance, but this was vetoed by the Mayor, partly on legal grounds, with the remark, in conclusion, that "the time immediately preceding a municipal election is the worst that could be selected for pressing a matter of this character." Although the order was passed over the Mayor's veto no action was taken under it.

In the summer of 1900 the Board of Health again took up the campaign against the reduction works, but without avail. The agitation, however, led to a proposition to have the works removed to an island in the harbor. This was fought, in and outside of official circles, for over a year, but on Oct. 10, 1901, the common council, by a vote of 61 to 12, passed a bill in concurrence providing for a payment of $140,000 to the New England Sanitary Product Co. for the removal of its plant to Spectacle Island, and extending the contract for ten years. A lawsuit to prevent the execution of the contract was unsuccessful.

The foregoing review of ten years' experience with garbage disposal at Boston does not settle the question raised by implication in our opening sentence, namely: Has garbage disposal been grossly mismanaged at Boston, or is the local Board of Health prejudiced? It seems to show, however, that both mismanagement and prejudice have prevailed to a greater or less extent. Certainly $140,000 is a heavy penalty for a city to pay a contractor for a mistake in locating his plant, and there can be little question but that prejudice is shown in the sweeping condemnation of all garbage reduction processes, contained in the quotation from the last report of the Boston Health Board.

But it is not our purpose to discuss specific questions of prejudice or mismanagement. Our readers are chiefly concerned in the broad problem of sanitary garbage disposal. Is the work, by

whatever method, an unavoidable nuisance? And if a nuisance, whether avoidable or unavoidable, is it at the same time a menace to health? Perhaps the last question should be discussed first. Of course any nuisance, whatever its name or nature, which so annoys people as to cause continued or frequently recurring worry is a menace to health through the strain which it imposes on the nervous system. It is chiefly by causing such strains, we take it, that a garbage disposal plant may become a menace to health. A badly operated plant, in close proximity to residences, schools or workshops, might work injury by causing windows to be closed in warm weather, and thus robbing people of fresh air and cooling breezes, while in extreme cases a few people with weak stomachs might be given nausea. But a properly located plant would rarely be near enough to inhabited places to cause windows to be closed or to give rise to nausea, and the combination of proper location, good design and efficient operation should be a safeguard against such trouble. Under these conditions, there would remain only the "wear and tear" of the nervous system due to unpleasant odors. Every community owes it to its citizens to render such odors so infrequent as to be of no real moment.

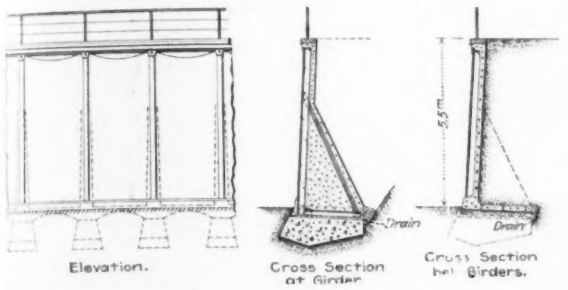


Fig. 1. Steel-Concrete Retaining Wall With I-Beam Skeleton.

It is at least an open question whether the concentration of large quantities of raw garbage at any point will not in itself give rise to decidedly unpleasant odors, regardless of the method of final disposal employed. This is a probability commonly overlooked in crusades against garbage disposal works. Eliminating this feature, as common to all methods of disposal, and assuming that for large cities cremation or reduction are the alternatives, the question is, which is the least likely to be a nuisance? Experimentally, we do not know, because there is not a single cremation plant in America at all comparable in size with the reduction works of Boston, New York, Philadelphia and other large cities. Theoretically, there are some strong arguments in favor of cremation, but in the absence of knowledge of comparative costs it is impossible to state whether even the theoretical advantage would be worth while. Certainly there is no evidence at hand to show that the sanitary efficiency of either process is so far superior to that of the other as to warrant any great extra outlay on its account, at least until sanitary improvements far more pressing in most communities have been made. Probably a thousand lives sacrificed to polluted water can be shown to every case of sickness, say nothing of death, due to either a garbage crematory or reduction plant.

LETTERS TO THE EDITOR.

Should City Engineers be Elected by Popular Vote, Appointed by the Mayor, or Chosen by the City Council?

Sir: In an editorial note in your issue of July 24, with reference to the proposed new charter for the city of Atlanta, you state that it is not plain why the engineer should be elected by the people, instead of being appointed by the mayor with the approval of the city council. In my opinion that provision is a safeguard in the interest of the people, rather than otherwise, especially in a city of the size of Atlanta.

Appointments by mayors and city councils are not always based on qualifications; in fact, they are more liable to be influenced by those having private interests in view, than the so-called politicians who are delegates to the party conventions. It must be remembered that most mayors and members of city councils, if not politicians themselves, rely upon some of them to name the officers, the engineer included. It reduces the case then to a question of which is the easier way to get the office; whether it is easier, by whatever methods employed, to influence 8 or 9, as with the mayors and councils, or a majority of about 100 delegates in convention.

The nominee of a convention for the office of engineer is generally well known in the community in which he lives, and he must have some qualifications, other than personal popularity, to get the vote necessary to elect, as at this date the average voter is pretty well informed.

Surely there are some able engineers who are not good vote-getters, but there is no reason why a good engineer should not be a fair politician, for it requires about an equal amount of brains in one as in the other.

It is true that where an engineer is elected by the people he must be a gentleman, accommodating and courteous, and devote considerable of his time to the study of politicial methods; but he should do these things to be a good citizen, whether he has the office of engineer or not.

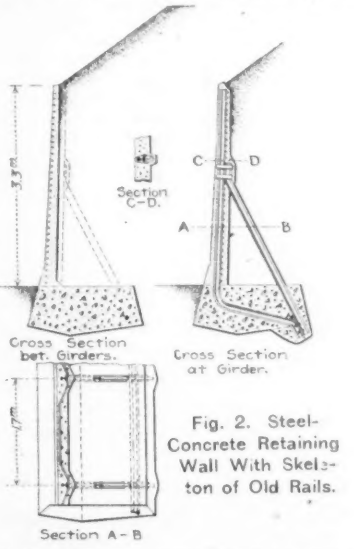


Fig. 2. Steel-Concrete Retaining Wall With Skeleton of Old Rails.

I have found that the office of the engineer is further removed from the so-called influence of politics by being elected by a direct vote of the people than when appointed.

However it may appear, it is nevertheless true that the officer who is appointed by a council or mayor constantly finds himself in the position of being considered under personal obligations to some of its members and will unconsciously be governed, to a certain extent, by their wishes.

They have the ax to grind and have it always in hand.

With the voters at large it is different, for although some few may feel that the incumbent holds office through their individual efforts, yet they can more easily be convinced that there is a multitude having equal claims with themselves on his gratitude. Yours truly,

Emmet Steece, Assoc. M. Am. Soc. C. E.
Office of City Engineer,
Burlington, Ia., July 28, 1902.

(As this is a subject that vitally affects many other city engineers we should like to have brief expressions of opinion, pro or con, from all over the country.—Ed.)

The Appearance of Exposed Surfaces of Concrete.

Sir: In the July 3, 1902, issue of Engineering News, the question of the mottled appearance of exposed concrete surfaces was discussed editorially and contributions relative the remedying of these defects were invited.

It is extremely doubtful if, under the conditions which concrete is usually made, an uniformly colored surface can be obtained. This is because of the following reasons: Concrete is generally made up in batches of 1 cu. yd. or more of materials. Each class of material is measured out and dumped together in a body, with the result that there is no intermixing of the various ingredients until the same has been deposited in the mixer. It must be obvious that to obtain a homogeneous compound from this procedure is extremely difficult. Some portions of the mixture will contain more cement than the rest, imparting to it a lighter color. Should the sand contain any earthy matter, and it is hard to find any that is perfectly clean, this, when the water is added, will produce more or less discoloration. The same can be said of the broken stone.

It will be noticed that the surface of hand-mixed concrete is always more uniform in color, due to the manner in which this concrete is made. The sand being spread over a large surface and in thin layers, the cement then being spread uniformly over the sand and the whole then turned over with shovels or hoes, producing a mass more or less uniform so far as the disposition of the ingredients is concerned.

The ideal way of making concrete would be an arrangement whereby the various measured ingredients could be fed simultaneously into a charging box, but then it is extremely doubtful, that after having passed through the mixer, that the different ingredients would be found to be uniformly distributed.

The foregoing has particular reference, where the exposed surface of the concrete is obtained by placing it next to the forms, raking back the stone and then manipulating the finer concrete with spades worked up and down, between the forms and the concrete. Where this work is faithfully done, an absolutely smooth surface is the result, but the concrete mixture must be wet to attain it.

Where the exposed surface is obtained by placing a thin layer of mortar next to the forms, a surface comparatively free from spots can be obtained by carefully mixing the sand and cement in quite small batches, the idea being to obtain a mixture in which the ingredients are uniformly distributed. Care should also be taken to keep the forms perfectly clean or discolorations will be the inevitable result.

In this connection it is interesting to note the number of well-known engineers who are in favor of wet concrete. The writer has always been an ardent advocate of this kind of a mixture and has certainly cause for self-congratulation to find himself now in such good company.

Mr. Thomas S. Clark gives in page 63 of the July 24 number of Engineering News, a table giving relative strength of sand and stone dust mortars. For the purpose of comparison I append the following tests of briquettes made from one part cement and three parts limestone dust:

	Hrs.	Days.						
Age....	24	7	14	21	28	35	42	49	56
Weight.	45	265	320	390	380	373	597	560	578

Respectfully,
Emile Low, M. Am. Soc. C. E.
Buffalo, N. Y., July 28, 1902.

A New Design of Concrete-Steel Retaining Wall.

Sir: In the issue of Engineering News of March 27, 1902, I am much surprised to find an account of "a new design of concrete-steel retaining wall," of which Mr. Frank A. Bone, Civil Engineer, claims to be the inventor, and which is stated to have been for the first time carried out in the United States during the summer of 1901.

As a matter of fact I was struck some years ago (August, 1897), together with a friend of mine, Mr. Kr. Moller, C. E., by exactly the same idea, and the first retaining wall of our design was constructed in this country during March, 1898. Since then a number of retaining walls have been constructed according to our design.

Our invention is protected in Denmark, Sweden and Norway by a patent, which was granted us in this country from April 21, 1899. In our application we claimed as our invention: "a retaining wall, having an L-shaped cross-section and consisting in two flanges, one vertical and one horizontal, in some way or other rigidly secured to each other, and the horizontal flange being wide enough to let the weight of the retained material resting upon it counterbalance the horizontal pressure of the retained material against the upright flange."

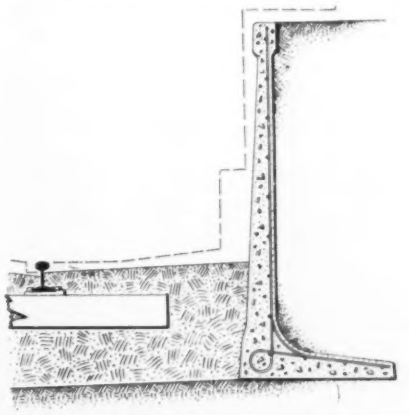


Fig. 3. Steel-Concrete Retaining Wall With Skeleton of Steel Rods.

During the spring of 1898 we attempted to patent our invention in the United States; we consulted a well-known patent "advocat" in New York, who after a preliminary examination of our case informed us, that in consideration of the American patents Nos. 489,792/1893, and Nos. 268,441/1883 (relating to a pottery border for garden beds, mirabile dictu!), he did not consider it likely that a patent would be granted us; so we resigned. Now, seeing that Mr. Frank A. Bone succeeded in obtaining this patent we can only regret that we trusted the "advocat!"

The acompanying drawing, which has been taken from our publication of the matter in the gazette of the Institute of Civil Engineers, Denmark, shows some ex-

amples of this novel type of retaining walls. Fig. 1 relates to a construction consisting of steel girders having between them vertical and horizontal concrete arches (the latter being—as will be seen in the drawing—of the Melan system).

Fig. 2 relates to a design, in which the steel girders are made of worn-out rails, and whose horizontal arches have been combined with the girder foundations so as to form one single continuous body, the front wall consisting of a concrete-steel plate (of Monier's system) resting against the girders. This type was carried out in this country 3½ years ago.

Fig. 3, finally, embodies exactly the self-same idea as does the wall designed by Mr. Frank A. Bone, the only difference being that the thickness of the concrete is somewhat smaller, and the necessary amount of the steel to be put in, therefore, correspondingly larger in our design than in that of Mr. Bone.

At short intervals steel bars are embedded in the rear of the wall and in the upper part of the heel, viz.: where the tensile strains come; the drawing shows one of these bars, and it will be seen that all of them are connected to each other by continuous horizontal steel rods (shown as black points), to which they are tied up by means of thin and soft iron wire (Monier's system of concrete-steel designing); the drawing also shows how the bars are looped in order to approach to the toe of the wall and so getting rigidly fastened in the concrete. In the type shown by Mr. Frank A. Bone you will find just the same idea, concerning the embedded steel bars being anchored in the toe. We also have used for absorbing the tensile strains "expanded metal"; indeed any system of strengthening concrete by means of embedded steel can be adopted for this purpose.

The first retaining wall ever constructed in this country (September, 1898), according to our invention, was of the last-mentioned type. The height varied from 3 to 9 ft., the length being 300 ft.; it retains a railway dam and during these four years of existence it has done extremely well in every sense.

Large quantities of still lower walls (from 2 to 4½ ft. of height) are used in this country for retaining the platforms of railway stations, for which purpose they are made beforehand in lengths of 6 ft. each and when sufficiently hardened they are conveyed to the place where they are to be erected. Fig. 4.

Faithfully yours, J. Lehman, C. E.

Copenhagen, Denmark, July 16, 1902.

The Cost of Brick Pavements.

Sir: I desire to offer a few remarks upon the above subject in connection with the article by Mr. Halbert Powers Gillette on "The Cost of Brick and Stone Block Pavements," published in your issue of July 24. I heartily agree with all Mr. Gillette says concerning the dearth of data on this subject; but some of the results of investigations recently made by the writer differ considerably from those presented by Mr. Gillette, and some that the writer obtained Mr. Gillette did not present.

The writer has some data from a small city in central Illinois showing that the cost of dressing off the subgrade after it had been graded with wheel scrapers, and throwing the material into wagons was 2.6 cts. per sq. yd. The cost of rolling the subgrade will depend upon whether it is rolled longitudinally only or both longitudinally and transversely. With a horse roller the cost of rolling the street longitudinally will not be more than 0.1 to 0.2 ct. per sq. yd.; but the interest on the cost of the roller will depend upon the amount of work done per year, and may be from ½ to 1 ct. per yd.

In a small city of central Illinois, the average cost to the contractor of mixing and laying 6 ins. of concrete during two years was about 7 cts. a sq. yd., for 1 part cement, 2 parts sand, and 4 parts broken stone, turned six times, exclusive of casting into place. With gravel instead of broken stone, the cost was about 6 cts. a sq. yd.; and with four turnings instead of six, the cost was about half a cent less than the prices above. All mixing was done with shovels. The wages of common laborers were $1.50 for ten hours.

Some contractors haul and pile the brick upon the side of the street before the grading is begun; while others haul the brick after the concrete is laid and deliver them directly from the wagons to the pavers, first having laid plank upon the brick already in place, over which to haul. It is claimed that the second method is from 2 to 3 cts. per sq. yd. the cheaper. There are two objections to this method: (1) it may result in keeping the street closed longer than otherwise, owing to the failure of brick to arrive; and (2) hauling over the brick before they have been rolled is likely to disturb their position and thereby make the pavement somewhat rougher. The cost of hauling and piling clay blocks on the side of the street is about $1 per thousand for a haul of one mile, of which sum about half is the cost of loading and unloading and half the cost of team and driver; but the latter necessitates the use of three wagons with each team.

The results obtained by the writer as to the number of brick that a man can set in a day differs materially from that presented by Mr. Gillette. The number set in a day varies with the size of the bricks or the blocks. An average laborer can set 10,000 to 12,000 small brick in ten hours exclusive of preparing the surface. An expert will set 15,000 in ten hours, and men have for five hours set 3,000 per hour. "Under unfavorable circumstances nine men in 13 hours prepared the sandbed, set the brick, and completed the pavement at the rate of 3,160 bricks per hour per man."*

An ordinary laborer can set 8,000 or 10,000 3 × 4 × 9-in. blocks in ten hours, and a good man will set 10,000 to 14,000. The organization of a paving gang is usually about as follows:

1 man in charge of spreading the sand cushion	$2.50
1 helper on the sand cushion	1.50
6 men wheeling blocks from wagons	9.00
4 men setting blocks	10.00
1 man sweeping pavement and filling joints with sand	1.50
Total, per day of ten hours	$24.50

This gang should lay at least 1,000 sq. yds. in ten hours, and under favorable conditions should lay 1,200 sq. yds. The cost then of the laying, including preparing the sand bed, setting the blocks, and filling the joints with sand, and including also general superintendence, is from 2¾ to 3½ cts. per sq. yd. These prices have frequently been obtained in central Illinois. If the blocks are piled upon the side of the street, one and possibly two more men will be required to deliver the blocks, depending upon the height and condition of the surface upon which the blocks are piled; and the cost of laying will, therefore, be increased 2 or 3 cts. per sq. yd. Not infrequently the cost of laying the brick is 8 or 9 cts. per sq. yd.; but this excessive cost is due to poor management.

According to Mr. Gillette, four pavers will lay from 8¾ to 12½ sq. yds. per hour per man (i. e., will set from 2,000 to 3,000 brick per hour, of which 57 make a square yard); while the writer has incontestable evidence that men in Illinois and adjoining states frequently, and under some contractors always, set from from 25 to 30 sq. yds. per hour, or two or three times that stated by Mr. Gillette.

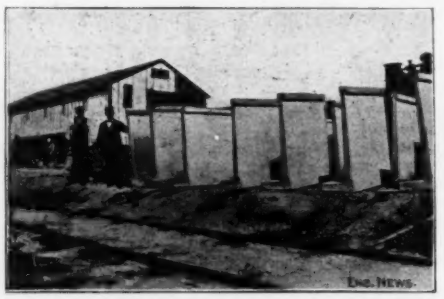


Fig. 4. Sections of Steel-Concrete Retaining Wall Ready for Shipment.

In a particular case, 80 hours were required to turn the chipped blocks and replace the rejected blocks with good ones in 1,633 sq. yds. of pavement, or say one hour for 20 sq. yds. The blocks were 3 × 4 × 9 ins., and about 2% were turned and about 2% were rejected.

The total cost of a brick pavement will then be about as follows:

Items.	Cost per sq. yd.
Subgrade: Rolling	$0.002
Concrete, 6 ins. thick: Materials	.40
Labor laying	.07
Sand cushion: 2 ins. of sand at 90 cts. per cu. yd.	.05
Labor spreading	.005
Brick blocks, 4 ins. deep; f. o. b. destination	.60
" hauling to the street	.04
" setting	.02
" rolling	.003
" turning and removing	.01
Filling joints with sand, and top dressing	.02
Total, exclusive of administration, tools, profits, etc.	$1.26

If the joints are to be filled with Portland cement grout, add 8 to 10 cts., according to the price of cement and the width of the joints. The cost of the labor in mixing and applying the grout in small quantities, according to the recent recommendation of the committee of the National Brick Manufacturers' Association, is about 1 ct. per sq. yd.

The average cost of a large job constructed by the city of Minneapolis, Minn., in 1897, by the city's force is given below.† The foundation consisted of 6 ins. of concrete composed of 1 part natural cement, 2 parts sand, and 5 parts broken stone. The bricks were made in Galesburg, Ill., and were 2½ × 4 × 8 ins. They were re-pressed and were guaranteed for ten years. They cost $15.54 per thousand, or 87 cts. per sq. yd., f. o. b. cars Minneapolis, after about 420 miles of railroad transportation. The joints were filled with a patent filler under contract with the manufacturers of it. Expansion joints ½-in. wide were inserted across the street about 150 ft. apart. The wages of common labor were $1.75 per day, and pavers $2. Teams received $3.50 per day.

Items.	Cost per sq. yd.
Removing old pavement	[illegible]
Grading	035
Concrete	032
Planking, concrete, lumber and miscellaneous	067
Brick	608
Hauling	870
Sand cushion	038
Laying brick	018
Murphy joint filler	032
Total	175
	.675

Before closing this communication the writer desires to refer briefly to a matter only remotely connected with the above. He has recently inspected a number of brick pavements in Terre Haute, Ind., which are much the best the writer has ever seen. A pavement on the main street (the city has a population of 36,763 according to the last U. S. census) had been in service 11 years; but was nearly as smooth as the marble mosaics of large office buildings, and there were almost no chipped or broken brick. The joints were filled with Portland cement grout 1 to 1, and are even yet level full. The face of the brick have not worn rounding in the least. In your issue of March 6, 1902, you published an article by the writer giving some results for the tractive resistance of several brick pavements, the lowest resistance being for the pavement in front of the writer's home; but without having made any tests on the Terre Haute pavements the writer is of the opinion that the tractive resistance of these pavements would be considerably less than the least value in Table VI. in the article of March 6, possibly only half as much. Apparently the superiority of the Terre Haute pavements is due to only two things, careful construction and the use of a good Portland cement grout carefully applied. The effect of minor details in the construction of a brick pavement is shown by a comparison of the tractive resistance of pavement No. 4, Table VI, of your issue of March 6, with that of Nos. 5 and 6. The former has a resistance of 17 lbs. per ton, while the last two have 31 and 22 lbs. per ton, respectively. Further study and observation since the publication of that article convinces the writer that the greater tractive resistance of the last two pavements was due almost entirely to two causes: (1) lack of care in preparing the sand cushion, and (2) lack of care in rolling the brick, the former being considerably the more important. Yours truly,

Ira O. Baker.

Champaign, Ill., July 30, 1902.

NEW LOCOMOTIVE WORKS AT LIMA, O.

The Lima Locomotive & Machine Co., of Lima, O., whose specialty is the Shay geared locomotive, has now under construction an entirely new plant, covering about 15 acres. The capacity of the plant will be an average of one engine per day, the engines varying from 10 to 140 tons in total weight. The several buildings are all connected by a system of standard-gage tracks, to be operated by a Shay engine, and there are sidings leading to the tracks of the Erie Ry., the Cincinnati, Hamilton & Dayton Ry. and the Lake Erie & Western Ry. There are complete systems of sewerage, water supply, electricity and fuel gas, and the buildings are heated by hot air delivered by a blower system, which is furnished by the New York Blower Co. The buildings were designed by the Osborn Engineering Co., of Cleveland, O., which company is also superintending the construction.

The machine and erecting shop, A, is 120 × 220 ft., with brick walls, steel roof trusses and a tile roof. The first floor is paved with concrete, and the second floor (in the side bays) is of slow-burning construction. The middle span is 60 ft. wide, with a height of 38 ft. to the rails of the two traveling cranes. This is the erecting shop, and has four tracks running its full length, with capacity sufficient for 20 locomotives. On each side is a two-story bay 30 ft. wide, in which are the machine tools and other appliances.

The blacksmith shop, B, is 74 × 165 ft., built of brick, with a slate roof. It is equipped with oil and gas furnaces, forges, forging machines, steam hammers, etc. Adjoining this is the frame and truck shop, C, 74 × 125 ft., containing wheel-boring machines, wheel presses, axle lathes, special drills for arch bars, punches, cut-off saws, etc.

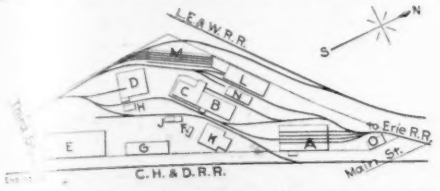
The boiler shop, D, is 120 × 140 ft., of steel frame construction, with brick walls and a tile roof. It has a center span of 60 ft., and two side spans of 30 ft. At one end is the erecting tower, with hydraulic riveter. A 15-ton electric crane serves the 60-ft. floor, while the side bays have several smaller traveling cranes. All the tools are driven by electricity. The large tools, bending rolls, punches, etc., have direct-connected indi-

*Municipal Engineering, Vol. 3, p. 129.

†Jour. Assoc. Engineering Societies, Vol. 20, p. 235-38.

vidual motors, while the smaller tools are belted to a shaft driven by a motor. The hydraulic power for the flanging presses, etc., is transmitted from an accumulator in the power house.

The iron and steel foundry, E, is 300 × 120 ft., of similar construction to the boiler shop. It has the same cross-section, with an electric crane in the 60-ft. middle span, and smaller traveling cranes in the 30-ft. side spans. The cupolas for iron and converters for steel are in one side bay,



Plan of New Works of the Lima Locomotive & Machine Co., Lima, O.
Osborn Engineering Co., Cleveland, O., Designers.

near the middle; the core ovens, drying ovens and annealing furnaces for steel castings are in the same bay. The middle span and the other side bay are used for molding and pouring floors, all the materials for these being stored in sheds at the side of the building, so as to reduce the cost of handling. The brass foundry, F, is a brick building, 43 × 22 ft., with slate roof. The pattern-storage building, G, is 200 × 60 ft., with brick walls, steel roof trusses and tile roof. It is lighted entirely by roof skylights. Patterns will be carefully classified and indexed. The building, H, 60 × 125 ft., is for storing patterns, etc., which are not in constant use. At J are the sand and coke bins, 20 × 80 ft.

The building, K, is a frame structure, 93 × 100 ft., in which iron and steel castings are stored and classified, as a large stock will be kept on hand. This building has railway tracks inside, and is served by several cranes. The planing mill and woodworking department are contained in a brick building, L, 70 × 200 ft., with slate roof. This is fitted with an exhaust system for removing dust and shavings. Beyond this is a storage building, M, 70 × 323 ft., having four railway tracks. This building has a wooden frame, with corrugated iron sides and roof.

The power house, N, is a brick building, 40 × 117 ft., with tile roof and cement floors. Two Scotch marine boilers of 250 HP., with Morison corrugated furnaces, supply steam for an engine of 450 HP. This drives two Sprague generators of 100-K-W. capacity, furnishing current for power and lighting. The air compressor, the blowing engine for the steel converters and the hydraulic plant for the flanging presses and riveting machines in the boiler shop are located in the power house. Finally, there is a three-story brick office building, O, 40 × 80 ft., which contains the several offices and the drafting department.

A HANDY MACHINE FOR TAKING SOUNDINGS.

By Otto Gersbach.*

In the construction of a harbor which the Lake Michigan Land Co., of Chicago, is now building at Indiana Harbor, Ind., it was necessary to take a large number of soundings, and a special machine was designed by Mr. Ben. C. Rich, Assistant Engineer of the company, for this purpose. It is simple in construction and operation, is inexpensive, and has proved a great saving of labor over other methods I have seen employed for this work.

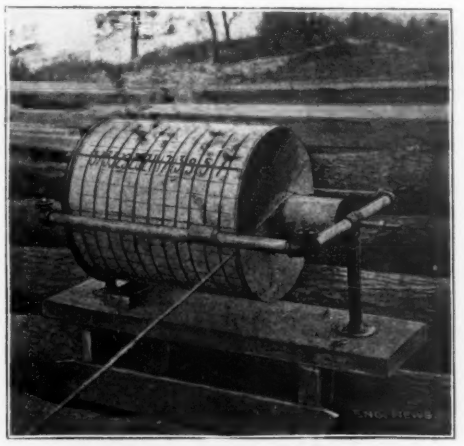
The machine consists principally of a drum 4 ft. in circumference and 18 ins. long, with a smaller drum 4 ins. in diameter and 6 ins. long to the right of this, as shown in the accompanying cut. These are carried by a ⅜-in. axle projecting 3 ins. beyond the supports at each end. The whole machine is mounted in a gas-pipe frame. Around each projecting end of the axle is wound a piece of light picture wire, which extends around pulleys and across the face of the large drum, and is attached to a sliding carriage, which carries a pointer for showing the readings. This wire is wound in opposite directions around the axle at either end, in such a way that as the drum revolves to lower the plumb-bob the pointer moves from right to left. As the plumb-bob is raised, the pointer moves to the right.

The sounding wire is wound around the extreme left of the larger drum. The main part of this drum is graduated as shown, and from these graduations the recorder takes his readings. Around the smaller drum is wound a ¼-in. rope for raising and lowering the plumb-bob.

The graduating was done after the machine had been fitted up. The drum was first divided by four horizontal lines, which were a foot apart. These divisions were subdivided into tenths by lighter lines parallel to the others. The spiral division line, extending around the drum, was first traced by a pencil point held firmly on the pointer while the drum was made to revolve.

The machine is placed on a base which rests and is fastened firmly in the back end of the boat, but the cut shows it mounted on a pile of logs for convenience in photographing. One man operates the machine by the rope, which works very easily; a second man does the recording, while a third rows the boat. By taking a little more time one man can do the work of the first two.

The levels in this case are all referred to Chicago city datum. Before taking soundings, the



A Machine for Making Soundings.
Ben. C. Rich, Assistant Engineer, Lake Michigan Land Co., Chicago, Designer.

level of the lake is read from a gage near the work, and the plumb-bob is so set that the reading recorded from the machine is in feet and tenths of feet below city datum.

The machine was made by a tinsmith and cost complete, exclusive of wooden base, $6.85.

*247 Monadnock Block, Chicago.

AN AMERICAN-BUILT BRITISH DISTILLING SHIP.

A few weeks ago there sailed from the port of New York, bound for Bermuda, a distilling ship which had been ordered by the British War Department through Mr. W. B. Smith, Consulting Engineer, of 29 Broadway, N. Y. This vessel is the third ever built solely for distilling purposes, the other two being the "Iris" and the "Rainbow," both of the U. S. Navy. The new vessel, named the "Edgewater," is not only the smallest distilling ship afloat, but is believed to have a larger capacity in proportion to its size than any other. It is also remarkable from the fact that it is probably the first vessel for war use ever ordered by the British government in America.

The principal features of the arrangement and equipment of the "Edgewater" are shown in the accompanying drawing. The distilling outfit is placed on the main deck forward of the engine and boiler room and is covered in by a deck-house. The corresponding numerical data are: Vessel, length, 96 ft. over all; beam, 25 ft.; draft, 7 ft. 6 ins. Engine, fore and aft compound, with cylinders 16 and 27 ins. by 16-in. stroke. Wheeler surface condenser, duplex air pump, and independent circulating pump of the centrifugal type. Boiler, oval Scotch, 8 ft. 6 ins. wide, 11 ft. high, 9 ft. long, with two corrugated furnaces 42 ins. in diameter. One Blake boiler feed pump, and one Metropolitan injector.

The distilling plant consists of six evaporators, each 5 ft. in diameter by 8 ft. high, arranged to be connected for either single, double or triple effect. Steam is supplied to the evaporators from the main boilers at 100 lbs. pressure. The vapor is condensed by three copper "distillers," each 27 ins. in diameter by 4 ft. 5 ins. high. Water is supplied to the evaporators by two duplex steam pumps from the hot discharge of the circulating water of the "distillers;" the circulating water is supplied by two duplex pumps, 7½ × 8½ × 10 ins., connected to sea by an 8-in. gate valve. The steam from the first effect, together with drain and exhausts from the auxiliary machinery, goes to a 30-in. × 6-ft. feed water heater, and thence drains to the hot well of the main engine. The distilled water passes to wooden storage tanks, which have a capacity of 11,000 gallons. These tanks are discharged by means of a pump, the necessary hose connections being provided for discharging to shore or to a lighter. The distilling plant was supplied and erected on board by the Jas. Reilly Repair & Supply Co., of New York.

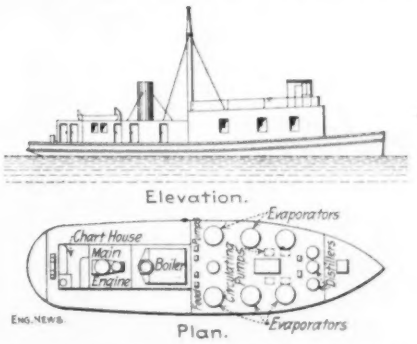
The official evaporating test of the "Edgewater," preliminary to her acceptance, gave the following results:

Boiler pressure, average	87½ lbs.
Pressure in shells of evaporators: High pressure	26 "
Intermediate	13 "
Low pressure	1 "
Water evaporated in 24 hrs., gallons	50,240
Temperature of salt feed	200° F.
Temperature circulating water	67° F.
Temperature fresh water discharge	95° F.

The vessel has a normal speed of nine knots per hour, but while distilling this speed is reduced to four knots.

It may be worth while in this connection to refer to the equipment of the "Iris" and the "Rainbow," the two distilling ships of the U. S. Navy. These vessels are fitted with the Baird distilling apparatus of M. T. Davidson, 43 Keap St., Brooklyn, N. Y. This same type of apparatus was furnished by Mr. Davidson to the floating machine-shop "Vulcan," to the transport "Sumner," and to a large number of other vessels of the American navy.

The "Iris" and the "Rainbow" have almost identical distilling equipments. That of the latter vessel is described in Engineering News of March 29, 1900, after the "Journal of the American Society of Naval Engineers." It consists of twelve evaporators, each 5½ ft. in diameter by 6 ft. 2½ ins. long, and having 350 sq. ft. of heating surface in the form of 1½-in. brass tubes; four condensers (size not given), three feed pumps, two brine pumps, and three feed water heaters. The evaporators can be connected for single, double



Distilling Ship "Edgewater," of the British War Department, Bermuda.
Equipped by W. B. Smith, 29 Broadway, New York.

or triple effect. The capacity of either vessel is about 60,000 gallons in 24 hours, the evaporators being connected in multiple.

BREMEN, GERMANY, is being sewered, after an existence of centuries. In 1899 it was ordered that all houses built after that date—on streets provided with sewers, should be equipped with water-flushing closets. The city has now decided to construct a complete system of sewers, and to abolish the "Tonnen" system, introduced in 1893. By this latter system all household refuse was placed in buckets with tight-fitting covers, and regularly collected by the city. Under the proposed system the sewage is to be carried to a sandy region nearby and disposed of by broad irrigation. U. S. Consul H. W. Diederich, of Bremen, says that this improvement will create a large demand in Bremen for water-flushing closets and bath-room fittings. Bremen has a population of 182,000.

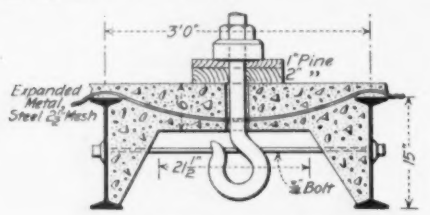
TEST OF A CONCRETE SLAB REINFORCED WITH EXPANDED METAL.

By O. W. Connet.*

In connection with plans to replace wooden floors on some bridges in Baltimore, it was decided to make a test to destruction of a 6-in. concrete slab, reinforced with expanded metal. The result of the test is such as to be of general interest. The test was made as shown by the accompanying sketch.

Two 15-in. I-beams about 6 ft. long were placed on top of two stout wooden trestles about 8 ft. above the ground and fastened rigidly, 3 ft. apart, c. to c., by two 2 × 12 × 35-in. plank placed 4 ft. apart and held together by two ¾-in. bolts just inside the plank. A form was made of 1-in. plank, such that the concrete would be 6 ins. thick for a width of 21½ ins., having a bearing on the lower flange and finishing 1½ ins. above the top of the I-beams. The concrete was thoroughly rammed in between the form and I-beams and brought up to proper position of the expanded metal, which was then laid across the top of the beams and bent down 4 ins. in the center. A piece of 3-in. water pipe, 5½ ins. long, was placed on end in the center of the slab and forced through one of the meshes of the expanded metal down onto the form, so that the top of the pipe finished ½-in. below the top of the concrete slab. The concrete was then filled in to the required thickness. The sheet of expanded metal used was No. 16 gage steel, with 2½-in. mesh, and was 4 ft. long in the direction of across the beams by 3 ft. in the other direction.

The concrete was composed of one part American Portland cement (Nazareth), two parts clear, fine river sand and four parts of crushed gneiss stone of a size to pass through a 1½-in. ring down to ¼-in. stone. After the concrete had set for seven days, the form was removed, and on the 28th day the test was made.



Plan and Section Showing Method of Testing Concrete and Expanded Metal Bridge Floor Arch.

A washer of Georgia pine, 12 ins. square and 3 ins. thick, was laid directly over the hole in the center of the slab, and an iron washer, 4 ins. in outside diameter, was placed on top of the wood, and a 2-in. bolt, with a hook on the lower end, was put through these and held by a nut. Four strands of a ⅞-in. wire cable were suspended from the hook and passed around six iron gutter plates 5 ft. × 6 ft. 8 ins. × ¾-in. thick. On these plates timbers and plank were arranged, on which street paving block were piled until the bolt pulled a hole through the concrete.

After about 20 tons had been put on, three minute cracks began to show on the under side of the slab, radiating from the center in practically straight lines towards the corners of the slab. These did not increase perceptibly as the load was increased, and there was no deflection of the top of the slab before it failed. When the slab failed, the bolt pulled through, carrying a conical shaped mass of concrete with it and tearing the expanded metal apart. The hole in the top of the slab was eliptical in shape, about 8 × 11 ins., while at the bottom it was more nearly square and about 20 ins. on a side. The tota' concentrated load on the bolt at the time of faiure was 28 tons.

The test was perhaps more severe than that which would result from any load that could ever happen on a bridge, as the pavement would distribute the load more than the washers did. In fact, the iron washer crushed its way into the wood over an inch, so that the wood did not distribute the load. The iron pipe through the slab probably weakened it from the neutral axis downward. As loads of 5 tons on one wheel are rare, this would give a factor of safety of between 5 and 6. All of the conditions of construction for this test can be duplicated in practice.

*Assistant City Engineer, Baltimore, Md.

A LABORATORY MIXER FOR DRY CEMENT AND SAND.

By C. J. Griesenaur.*

In the cement testing laboratory, when preparing a cement and sand mixture for briquettes, we feel the want of a device which will mix the materials together quickly and thoroughly, preparatory to adding the water and molding the briquette. For this purpose the drum mixer shown in Fig. 1 is used in the cement testing laboratory of the C., M. & St. P. Ry. Co. Fig. 2 shows an interior view of the mixer. In operation, the dry cement and sand are poured into the open end of the drum shown in Fig. 2 in the desired proportions, and the removable cap is replaced. The drum is then placed in the rack, as shown in Fig. 1, and given a few slow revolutions and the two materials are thoroughly mixed and ready to use. A couple of jars with the hand will remove any particles adhering to the interior.

The construction of the mixer is simple, and it can be made by any mechanic skilled in such kind of work. The cylinder is made of No. 16 galvanized iron. Inside the drum are eight rows of fins, which assist in the mixing. Each row of fins is cut from a single piece of iron and remains attached together by a ½-in. strip, which is bent at right angles with the fins and fitted and soldered to the inside of the drum. The fins are 1 in. wide and 1½ ins. long, with a 1-in. space between each fin. They are so placed that the fins of one row are just over the 1-in. space of the next row.

The drum is 12 ins. long and 8 ins. in diameter. The removable cap in this case is the bottom of an old 8-in. diameter brass seive. Its concaved side is filled with a 1-in. thick wood block, into the center of which a piece of gas pipe 3 ins. long is screwed. This gas pipe is the journal for that end of the drum, and also takes the place of a handle to remove this end for loading and unloading. A couple of rubber bands put around the outer edge of this removable cap will prevent any of the materials from leaking out while the mixing is in process.

The journal and crank at the other end of the drum is a hollow tin pipe soldered to the drum. By filling this pipe with a cement grout, when set, it can be greatly strengthened. The rack on which the drum revolves is so simple as to need very little description, it being a frame of two wood uprights to receive the journal of the mixer and high enough for the drum to clear the cross-piece which fasten the uprights together.

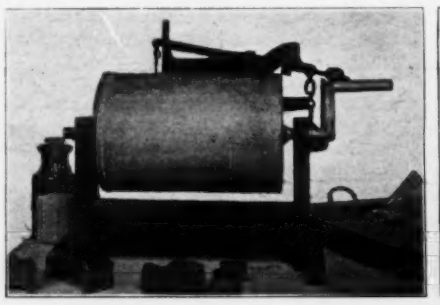


Fig. 1. General View of Mixer.

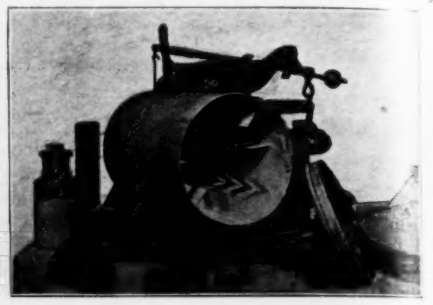


Fig. 2. Interior View of Drum.

A LABORATORY MIXER FOR DRY CEMENT AND SAND, CHICAGO, MILWAUKEE & ST. PAUL RY. TESTING LABORATORY. C. J. Griesenaur, Chicago, Ill., Designer.

The advantage of this little mixer is the thoroughness of its work, its inexpensiveness and the saving of time as compared to hand mixing. Its use also reduces, to the extent of the mixing at least, the personal equation in the work of cement testing.

The size of this mixer as given in above figures has proved to be a suitable size for ordinary-sized batches of mixtures for briquettes. The size can probably be reduced or increased to suit the amount desired to mix at one time without affecting its efficiency. The machine is original with the writer, and can, no doubt, be somewhat improved upon, and this should be borne in mind when duplicating. When time-saving is an object and uniformity is desirable, which is nearly always the case, the machine will be a great help and convenience. It has been used in the cement testing laboratory of the C., M. & St. P. Ry. Co. for nearly a year, and has become practically an indispensable apparatus.

*Cement Tester, Chicago, Milwaukee & St. Paul Ry., Chicago, Ill.

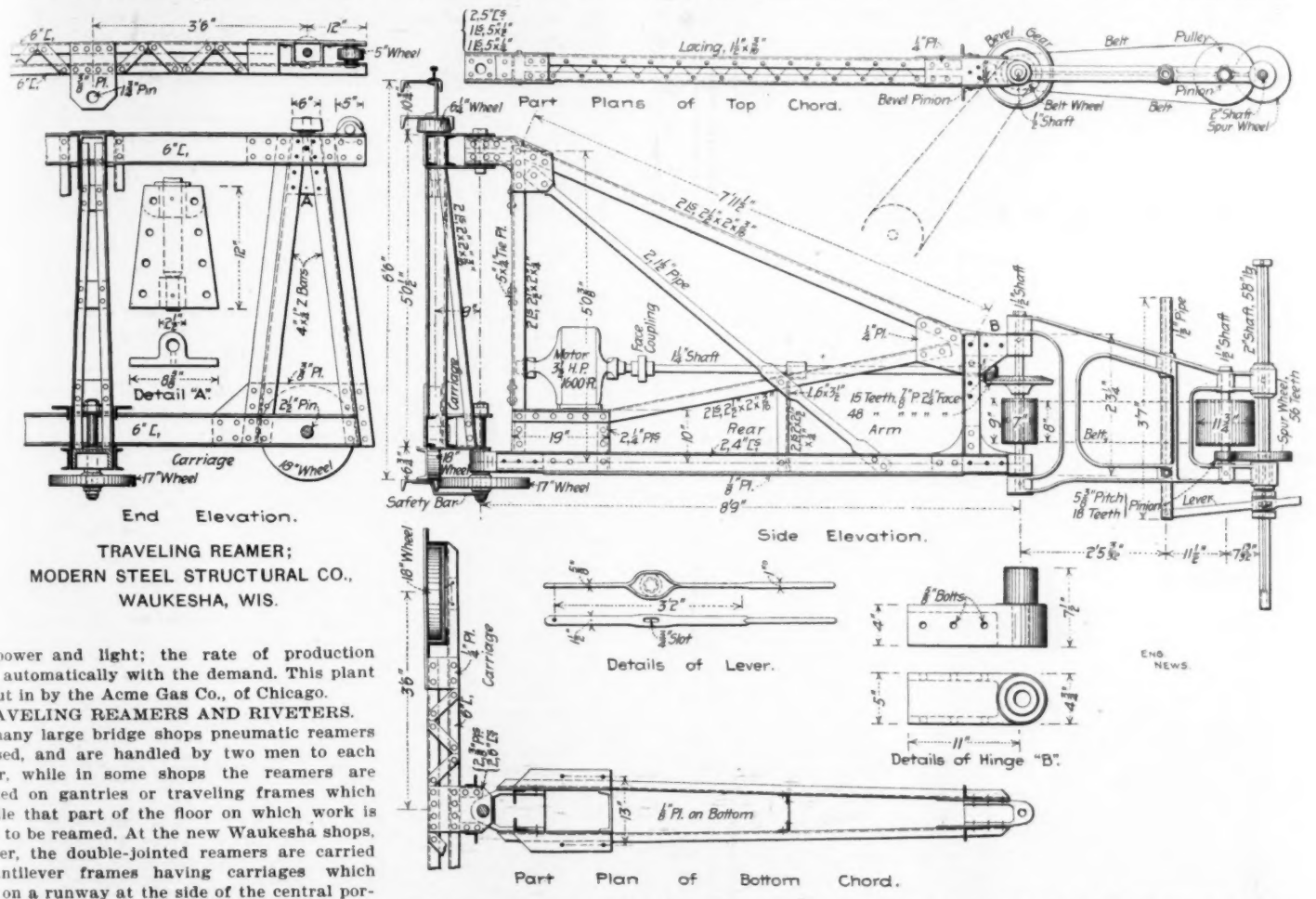
THE PLANT AND SPECIAL MACHINERY OF THE MODERN STEEL STRUCTURAL CO.

The works of the Modern Steel Structural Co., at Waukesha, Wis., are among the newest of the numerous bridge and structural works, having been opened in 1900 for general business. The present building is 240 × 104 ft., and an addition 162 × 145 ft. is now being built at one end. The purpose of this addition is principally to give sufficient capacity to handle larger railway work than could be handled in the first building. The machinery equipment will be of the most modern character, and with the new addition the plant is expected to be one of the most complete of its kind in the west. The plant is situated a short distance east of the city of Waukesha, between the Milwaukee and Madison line of the Chicago & Northwestern Ry. and the Waukesha branch of the Milwaukee Electric Railway & Light Co.

The buildings are of steel frame construction, with brick walls and steel roof trusses. The offices, drawing room and templet room are on a gallery over the main shop, sound insulating material being built into the walls and floor. The President of the company, Mr. S. B. Harding, was for several years with the Wisconsin Bridge & Iron Co., and for the new works he has utilized his former experience in specially arranging the plant and introducing a number of special features and machines for the purpose of facilitating the work and so reducing the cost of manufacture. Mr. F. W. Moore is the Chief Engineer, and was formerly engineer of the Milwaukee Bridge & Iron Co. (now absorbed by the American Bridge Co.). The present capacity of the plant (on the day turn alone) is about 5,500 tons per year.

which will be increased to 10,000 tons when the new addition is completed.

All the tools are operated by electricity, the larger ones having individual motors, while some of the smaller ones are grouped together and driven from a shaft driven by a motor. These motors represent an aggregate of about 112 HP. There will be in all four electric traveling cranes; one of 30 HP., two of 15 HP. and one of 20 HP. In the power house is a 50-HP. Nash gas engine, belted to an electric generator and a vertical air compressor; while a 75-HP. Nash gas engine is directly connected to a larger generator. The air compressor was built by Curtis & Co., of St. Louis, and supplies air at a pressure of 80 to 90 lbs. for the pneumatic riveters and other tools, hoists, etc. The Acme process is used for generating gas for the engines, the rivet rod furnaces and the rivet heating machines. Under this process, air is forced through a crude distillate of petroleum in a series of generators, producing a fixed gas which may be piped to any distance and used for fuel, power and light; the rate of production varies automatically with the demand. This plant was put in by the Acme Gas Co., of Chicago.



TRAVELING REAMER;
MODERN STEEL STRUCTURAL CO.,
WAUKESHA, WIS.

TRAVELING REAMERS AND RIVETERS.

In many large bridge shops pneumatic reamers are used, and are handled by two men to each reamer, while in some shops the reamers are mounted on gantries or traveling frames which straddle that part of the floor on which work is placed to be reamed. At the new Waukesha shops, however, the double-jointed reamers are carried by cantilever frames having carriages which travel on a runway at the side of the central portion of the floor. This arrangement leaves the floor entirely unobstructed, and when not in use the frame can be swung round against the runway so as not to interfere with the handling of material.

The accompanying cut shows the construction of one of these traveling reamers. The carriage, shown at the left, has in its lower chord a single 18-in. carrying wheel, 2½ ins. wide on the face, which runs on a steel channel placed with its flanges downward, and forming the lower runway. At the opposite end of the lower chord is a 17-in. horizontal guide wheel running against the outer face of the channel, while in the top chord (directly over the carrying wheel) is a 6¼-in. guide wheel running inside a similar channel and having its face turned conical to fit the slope of the flange of the channel. The cantilever frame is in two parts. The rear arm is a built-up truss 8 ft. 9 ins. long, pivoted to the carriage. The front arm is a casting about 4 ft. long, pivoted to the rear arm and carrying the reamer bar. At the rear of the frame is a 2½-HP. electric motor, driving by bevel gear a vertical spindle in line with the pivots of the front arm, and belted to another in the front arm. This latter spindle carries a horizontal pinion which drives a spur wheel on the reamer shaft. With this arrangement, the arms can be swung to any position to enable the reamer to reach any part of the work while the reamer is running. The feed is effected by the man in charge bearing down on the lever attached to a sleeve on the reamer shaft.

A somewhat similar arrangement is used for carrying the heavy pneumatic riveters, which are of the hinged jaw type. This frame is a cantilever 17 ft. 3 ins. long, hinged to trolley carriers on a runway above that of the reamer, but this frame has no auxiliary arm. The riveter is suspended from the beam of this frame. These devices, like several of the tools used, have been built at the company's shops, to its own designs. It is, of course, very desirable to have furnaces close to the riveters, and to have as little throwing about of the rivets as possible, although as a rule rivets have to be thrown considerable distances. It is proposed to install portable rivet heaters at the Waukesha plant, the heaters being carried by trolleys on I-beam runways and having flexible hose for the gas connections. In this way the riveter may be used at the most convenient location, and the rivet heater run to it, and shifted as required.

THE SHRINKAGE OF SOIL rolled in 6-in. layers has been investigated in the construction of the North Dike of the Wachusett Reservoir, near Clinton, Mass., and is reported upon by Mr. Alex. E. Kastl, M. Am. Soc. C. E., in "The Technic" for 1902. The length of the trench which was filled was 1,375 ft. About 500 ft. of this length was about 30 ft. deep, 30 ft. wide at the bottom, with side slopes of 1 on 1. The remainder varied in depth from 0 to 25 ft., and in width from 50 to 80 ft. between slope stakes, with side slopes of approximately 1 to 1, having been partially filled under a previous contract. The soil was excavated from an area of 64 acres to an average depth of 0.78 ft. About 60 acres of this area contained stumps. The land from which the soil was excavated was called sprout land—land which had been cleared of forest growth and again allowed to grow over with trees and brush. The volume of the soil measured in excavation was 80,355 cu. yds. The volume of the soil after it was deposited and compacted in the cut-off trench was 50,735 cu. yds., or 29,620 cu. yds. less than the volume measured in excavation. The final levels were taken a few days after the completion of the work. From the above it follows that the shrinkage of the soil was 37%, calling the volume of 80,355 cu. yds. 100%. This shrinkage includes roots ½-in. or more in diameter and stumps so far as they were originally embedded in the soil, but which were removed and burnt. Roots ½-in. or more in diameter, stumps or other wood were not allowed to be deposited with the soil in the cut-off trench. The soil was free from stones. The volume of the soil excavated was determined from levels taken when there was no frost in the ground. The first levels were taken after the ground was cleared of trees and brush, which were removed and burnt or otherwise disposed of, and before the contractor had commenced grubbing; and the final levels after the final excavation was finished. The volume of the soil excavation includes the roots and stumps so far as the same were imbedded in the layer of soil excavated. The levels extended over the entire area stripped and were taken not more than 25 ft. apart; that is, not less than 70 cuts or depths of soil were determined for each acre. The ground was divided into squares 500 ft. on a side, the corners of which were permanently marked, and the sides were used as base lines for the cross-section work. The average depth given, 0.78 ft. is the total volume of the soil excavated divided by the area, and is only intended to give some idea of the depth of the soil stripping. All the soil containing 4% or more of organic matter is removed from the reservoir site. The volume of the soil when in the trench was calculated from accurate cross-sections, taken not more than 25 ft. apart before and after the filling of the trench. Before rolling the soil it was watered as much as it would bear without sticking to the roller. The type of roller which was used weighs about 6,000 lbs., and is drawn by two horses. The cylinder of the roller is 5 ft. long and is composed of 19 cast-iron wheels, 3 ins. thick at rim, 10 being 2 ft. 11 ins., and nine 2 ft. 8 ins. in diameter, respectively, arranged alternately.

THE IMPORTS AND EXPORTS OF STEEL, says the U. S. Bureau of Statistics, form the most striking characteristic of this year's commerce in the reversal of values as compared with last year. The total imports of iron and steel manufactures, for the year ending June 30, 1902, amounted to $27,180,225 in value, as against $17,874,789 in the preceding year; while the exports of the same were $98,552,562, against $117,319,320 in 1901. The reasons given for this loss and gain are—That in 1899 and preced-

ing years there were exceptionally prosperous business conditions in Europe, an active demand and prevailing high prices for iron and steel. These conditions in Europe have materially changed and the demand and prices have declined; but the home demand has greatly increased and our prices have advanced. While these combined causes are sufficient to account for the changes noted, Mr. James M. Swank, Secretary of the Iron and Steel Association, warns our manufacturers that the previous activity of our export trade in iron and steel, in the last few years, was exceptional and abnormal; and the lesson taught is that our home market is always our best market. But, he adds, the era of very low prices in Europe seems to be over and our exports will soon assume normal conditions.

A SUBWAY FOR PIPES AND WIRES in the U. S. Navy Yard at Boston, Mass., is proposed and a bid for its construction was received on July 26. It is to be of concrete and twisted steel construction, and is designed "to carry the electric wires, water, air and other pipes for the whole yard." The floor and side walls are to be constructed in alternate, monolithic, 20-ft. sections. Where the roof forms the sidewalk asphalt expansion joints, 10 ft. c. to c., are to extend to within ¾-in. of the underside of the roof, and the upper part of the roof, or sidewalk wearing surface, is to be of 1-in. granolithic mixture, 1 part cement to 1½ parts fine granite chips, not exceeding ½-in. in size, surfaced with 2 to 1 cement mortar. Where the conduit extends across streets, all of which are to be paved with brick, the top of the concrete roof of the conduit must conform to the crown of the street, and the thickness of the roof must be increased by 3 ins. beneath tracks. Branches from the main conduit or subway will be built through intersecting streets. The subway is to be made waterproof by means of five layers of asphalt and four layers of felt, on the inner sides of the walls, and four layers of each material on the bottom. Wherever the width of the subway exceeds 3½ ft., an overhead trolley is to be provided, with heavy Coburn track, 12 bronze bushed ball-bearing Coburn trolleys, and four Yale & Towne triplex blocks, each of 2,000 lbs. capacity. The specifications call for domestic Portland cement, and refined Bermudez or Alcatraz asphalt. The specifications also state that "where proprietary articles are mentioned herein, bidders may base their proposals upon similar articles of equal value and efficiency, but the fact that they have done so must be stated therein." Only one bid was received for the work just outlined, namely, a total of $55,564 for the concrete and steel subway and 60 cts. per ft. for laying a 16-in. cast-iron water main therein. The government estimate for the work was $34,000. Rear Admiral Mordecai T. Endicott is Chief of the Bureau of Yards and Docks, Navy Department, Washington, D. C.

FIG. 1. PIERS OF WRECKED BRIDGE ACROSS THE CATAWBA RIVER, NEAR HICKORY, N. C.

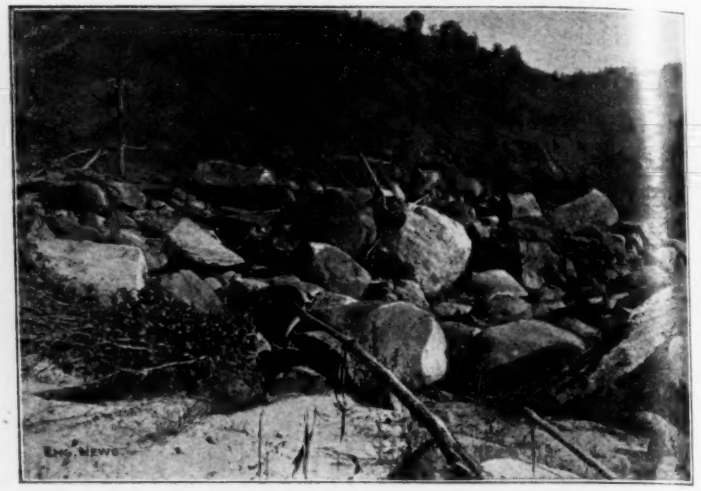


FIG. 3. VIEW OF BOULDERS CARRIED DOWN STREAM BY FLOOD IN CONE CREEK, BAKERSVILLE, N. C.

(The piers were erected in 1827, and supported the first bridge across the river. See text.)

THE ICE SUPPLY OF BOSTON has been under investigation by the board of health of that city since 1898, and some interesting results of the study are given in the report of the board for 1901. The total yearly amount of ice sold in Boston "is estimated at 300,000 to 400,000 tons, representing about 75,000,000 to 100,000,000 gallons of water; about equivalent to one to two day's tap water consumption." After careful inspection of all the conditions governing the production, storage and distribution of both natural and artificial ice, and after chemical and bacterial analyses of samples, and a review of the experimental work of Prudden, Sedgwick, Winslow and Park, the officials of the Boston board conclude that the danger of infection from the Boston ice supply is small, and natural and artificial ice are about equally safe. There is, however, some danger of typhoid infection, which the health authorities of every city would do well to take into account. Those caring to pursue the subject further will find some interesting statements, and also hints as to other sources of information, in the report named.

FIG. 2. VIEW OF WASHOUT AT GREENLEE STATION, N. C., ON THE CATAWBA RIVER.

THE COMMERCIAL PACIFIC CABLE CO. has signed a contract with the Telegraph Construction Co. of London, for making and laying a cable from Honolulu to Manila, touching at Guam. The construction company promises to complete the cable by June, 1903, provided the necessary soundings are furnished. The company has two steamers capable of carrying 6,000 miles of cable. One of these steamers is now loading the 2,400 miles of cable for the San Francisco-Honolulu line, and will sail in August.

A STUDY OF THE SOUTHERN RIVER FLOODS OF MAY AND JUNE, 1901.

An interesting study of the widespread Southern floods of May and June, 1901, has been made by Mr. E. W. Myers, Assoc. M. Am. Soc. C. E., of Greensboro, N. C. Mr. Myers is engineer of the North Carolina Geological Survey and Assistant Hydrographer of the U. S. Geological Survey. His study was made in the latter capacity and will be included in some future publication of the Survey, the date of which is uncertain. In order to make some of this interesting data available at an earlier date permission has been given by the proper authorities for the publication in these columns of an abstract of Mr. Myers' report.

The first period of rainfall and flood covered by this study extended from May 18 to 23, with its maximum intensity on May 21 and 22. The second period was June 20 to 24, the maximum intensity in this case being June 21 and 22. The May storm was most heavy over the crest of the Southern drainage areas from which water flows to the Atlantic Ocean, the Ohio River and the Gulf of Mexico; and the storm center was near the Black Mts., of North Carolina. The June storm was more restricted in area, affecting chiefly the valleys of Elkhorn Creek, Tug River and Dry Fork, in Southern West Virginia. Mr. Myers' report is confined to a single large stream, the Catawba River, in North and South Carolina, and two small streams, Cane Creek, in Mitchell Co., N. C., and Elkhorn Creek, in McDowell Co., W. Va. The Catawba River and Cane Creek floods occurred in May and the Elkhorn Creek flood in June. Before taking up either flood Mr. Myers embodies in his report an account of the heavy May rainfall in North Carolina, prepared for the purpose by Mr. C. F. von Herrmann, Director of the North Carolina Section of the Climate and Crop Service of the U. S. Weather Bureau. Leaving out some interesting statements regarding the cause of such heavy Southern rainfalls, figures as to the amount and duration of the storms may be extracted from Mr. von Herrmann's paper as follows:

THE HEAVY MAY RAINFALL IN NORTH CAROLINA.

The average rainfall for the state of North Carolina on May 18, 1901, was 0.23 in., and on May 19, 0.63-in. On the latter date the rainfall in

the mountain region was 0.85 in. The rains of the two days were sufficient to fill the rivers. In the next four days 3.63 ins. fell, making a total average for the state of 4.49 ins. in six days, against a normal rainfall of 0.84 in. for the same period. The variations throughout the state were marked, as shown by Table I., which gives the daily records by districts, and for the whole state, and also the daily normals and the totals for the

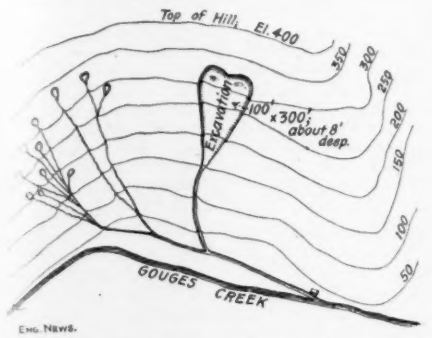


Fig. 4. Sketch Map of Waterspouts on Gouges Creek, Mitchell Co., N. C.

whole period. The maximum daily precipitations at single points on May 20, 21 and 22 were as follows: On May 20, at Cherryville, Gaston Co., in the Western District, 3.69 ins. On May 21, at Marion, McDowell Co., in the Western District, 7.25 ins. On May 22, at Moncure, Chatham Co. (district not stated), 5.95 ins. Table II. shows the maximum 48-hour rainfalls throughout the state for May 20 and 21 and for May 21 and 22. Table III. shows the total precipitation for the six days May 18 to 23 at the stations in the Central and Western Districts.

Mr. von Herrmann concludes his account of this storm with the following remarks on its effects:

These amounts of precipitation were sufficient to cause stages in the rivers in some cases higher than ever before known. The Roanoke at Weldon, N. C., attained on May 25 a maximum stage of 45.7 ft., nearly equal to the great floor of 1877, while the Cape Fear River at Fayetteville passed all previous records with 58.5 ft.

TABLE I.—Rainfall (inches) by Districts and for the State of North Carolina, May 18, to 23, 1901, Compared with Normal Rainfall.

	May						
	18th.	19th.	20th.	21st.	22d.	23d.	Total.
Eastern district	0.20	0.49	0.57	0.55	0.62	0.21	2.64
Central district	0.28	0.52	0.64	0.54	3.32	0.12	5.42
Western district	0.20	0.85	1.17	2.82	0.36	0.00	5.40
State	0.23	0.63	0.80	1.30	1.43	0.11	4.49
Normals	0.14	0.14	0.14	0.14	0.14	0.14	0.84

TABLE II.—Maximum 48-Hour Rainfall in North Carolina, May, 1901.

May 20 and 21.	Ins.	May 21 and 22.	Ins.
Cherryville	4.11	Asheville	3.93
Flat Rock	6.98	Bryson City	3.64
Henrietta	6.75	Charlotte	2.75
Highlands	4.60	Chapel Hill	7.23
Hendersonvile	5.79	Fayetteville	3.85
Lenoir	6.10	Greensboro	3.06
Marion	7.95	Henderson	4.55
Murphy	4.26	Lumberton	5.31
Patterson	6.84	Oak Ridge	4.16
Waynesville	3.31	Soapstone Mt.	4.18
		Raleigh	3.08

TABLE III.—Total Rainfall at Stations in the Central and Western Districts of North Carolina, for the Six Days, May 18 to 23, 1901.

Central District.	Ins.	Western District.	Ins.
Chapel Hill	8.68	Asheville	5.04
Durham	6.39	Bryson City	5.57
Fayetteville	5.44	Cherryville	5.39
Greensboro	4.21	Flat Rock	8.57
Henderson	5.00	Henrietta	7.11
Moncure	7.41	Hendersonvile	7.40
Oak Ridge	5.34	Highlands	5.04
Pittsboro	5.18	Lenoir	7.58
Raleigh	4.91	Morganton	4.50
Roxboro	6.90	Marion	8.93
Rockingham	6.85	Murphy	7.62
Saxon	5.02	Patterson	8.08
Southern Pines	5.22	Waynesville	5.25

FLOOD EFFECTS ON THE CATAWBA RIVER.

The course of this stream was followed and studied from its sources on the eastern slopes of the Blue Ridge Mts., in North Carolina, down to Rock Hill., S. C., below which but little damage was done. The destruction wrought by the flood was extensive. Crops were not only destroyed but the soil which supported them was either washed away or buried beneath sand and debris. Of even greater possible damage was the obliteration of the protecting fringe of trees and shrubs along the river bank. This protection lost, flooding and erosion may now proceed unchecked.

Only one ford was left passable along the course of the river, and not a single highway bridge was left in place. Fig. 1 shows what remains of the first bridge across the river, built about 1827. The superstructure of the original bridge was burned during the Civil War, but another one was erected on the same piers, the elevation being considered above danger from floods.

Fig. 2 shows a washout near the Greenlee station of the Western North Carolina Division of the Southern Railway. The washout is described by Mr. Myers as follows:

The river makes a large bend here and the railroad crosses the river, approaching on an embankment. As is sometimes the case on this stream the elevation of the ground surface at the foot of the river hills is somewhat less than near the river, and in this depression there was a small ditch, carried under the embankment by a culvert. When the river rose sufficiently to leave the banks it thus found a channel ready prepared for it. The capacity of the culvert was, of course, soon exceeded, and the water rose and topped the embankment, here about 12 ft. high, poured over, and began the erosion of a hole into which the embankment presently slid. When the flood receded the hole so eroded was seen to have a length of more than 100 yds. and a breadth of more than 50 yds., the depth being 18 ft. in places.

Near Morganton the water rose 31 ft. above low water, 10 to 12 ft. higher than had been known before, and carried away two steel highway bridges. Only parts of the wreckage of these bridges have been found and they were from 300 to 1,300 ft. below the site of the bridge.

In conclusion, Mr. Myers gives the following figures regarding the flow of the Catawba River:

This stream was gaged by the writer at the maximum flood height at the U. S. Geological Survey gaging station near Rock Hill, S.C., and a discharge of 150,825 cu. ft. per second was obtained, from a drainage area of 2,987 sq. miles, or more than 50 cu. ft. per second per square mile, and of this it is estimated that the greater part came from the upper river, above Catawba Station, where the drainage area is 1,535 sq. miles, and the estimated discharge at this time 95,000 cu. ft. per second, or 62 cu. ft. per second per square mile of drainage area. The greatest flood previously gaged at the Rock Hill station was less than 100,000 sec.-ft.

As has been stated this flood broke all previous records for this stream, the greatest previously known having occurred in 1865, and reaching a height about 2 ft. less than the May flood on the lower part of the river, the only place where definite water marks could be obtained for the comparison.

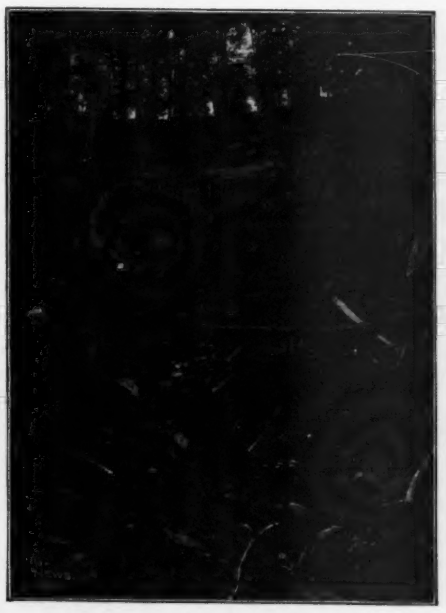


Fig. 5. View of Eroded Area.

Fig. 6. Edge of Eroded Area.

VIEWS OF EFFECT OF WATERSPOUT IN MITCHELL CO., N. C.

THE FLOOD ALONG CANE CREEK, MITCHELL CO., N. C.

Cane Creek drains about 30.5 sq. miles and discharges into the Nolichucky River, about three miles below Bakersville, a village of 300 inhabitants. Above Bakersville the stream has a drainage area of about 22 sq. miles. The stream, the flood along its course, and an estimate of the flood flow can best be described by the following portion of Mr. Myers' report, which has been very slightly condensed:

Cane Creek rises on the slopes of the Cane Creek Mountains, at an elevation of about 4,000 ft., having a total fall of about 1,650 ft. from source to mouth in a distance of about eleven miles, but being 25 or 30 ft., or even less, on its lower course. For seven or eight miles above the mouth the flood-plain has an average width of from 250 to 300 ft., but above this the level bottoms vanish and the valley is V-shaped, with steeply sloping sides, and is extremely rough, rugged and mountainous. Much bare rock is exposed on the slopes, and the soil is very thin and rocky where found, so that in time of heavy rainfall the soil soon becomes saturated and the storm-waters run off as rapidly as they fall, and though at low water the current of the stream is not especially rapid, on account of the roughness of the bed, the great slope of the main channel as well as that of the tributaries gives rise to very great velocities as the stream rises to flood heights. Equally on account of the great slope of the channel the stream never attained great heights, the ordinary flood height at Bakersville being from 5 to 6 ft.

This small rise was known and allowed for, and so harmless was the stream considered that the town was built directly along the banks, the stream flowing along one of the streets. All along the north bank of the creek in its course through the town was located a row of frame dwelling houses, most of them two stories in height, one church and a small mill. Of these the mill, church and 12 dwelling houses were swept away, while the others were filled to a depth of from 1 to 4 ft. with mud and sand and rendered uninhabitable for some time.

For three miles or more above Bakersville the bottom lands varied in width from 150 to 300 ft., and were on an average from 5 to 8 ft. above mean low water level, and the stream had a definite channel to which it was confined even during flood stages, this channel being about 50 ft. wide. The banks were fringed by trees and bushes whose matted roots resisted the erosive force of the current and protected the adjacent lands, which were of remarkable fertility, and of great value for this section of the country, most of them being valued at about $150 per acre.

The entire cultivated flood plain has been removed along the stream to an average depth of 3 ft., to bed rock, or to the underlying stratum of cobbles, and is absolutely valueless for any purpose whatsoever. It is estimated that this arable land amounted to about 250 acres, of which not more than 5 acres are now cultivable, and if the value of these lands be placed as low as $100 per acre the loss from this item alone will be not less than $25,000.

The stones belonging to the mill mentioned above were carried down stream about 200 yds. by the force of the current, and the wheel, a 20-HP. turbine, has not yet been found. This, however, ceases to be even a matter for remark when the enormous size of some of the boulders carried down by the stream is considered. Many containing from 2 to 8 cu. yds. and weighing from 4 to 20 tons were transported by the water for distances ranging from 100 to 300 ft. or more. Fig. 3 is a view of a pile of stones transported in this manner and left at the mouth of the stream. The large boulder in the middle of the picture is estimated to contain 14 cu. yds. and weighs about 39 tons, while another nearby contains 19 cu. yds. These, however, are exceptional and are located just below quite a considerable fall in the stream so that the velocities slightly above the place where these boulders are found were greatly in excess of those to be found on the stream in general.

It may be remarked in passing that the size of the stones so moved will afford some indication of the velocity of the water. In the work of Ganguillet and Kutter the follow-

ing formula is given for the velocity required to move stones or other heavy bodies immersed in water:

$$v = 5.67 \sqrt{a\,g};$$

where v is velocity in feet per second; a is mean diameter of body in feet, and g is its specific gravity. Assuming the specific gravity of gneiss as 2.7, a velocity of 20.6 ft. per second is sufficient to move a stone having a mean diameter of 5 ft.

When the flood reached its maximum height the water at Bakersville was about 12 ft. above extreme low water, the rise here being probably somewhat greater than at points above and below on account of a decrease in the slope of the channel.

While such floods as this are of interest to the general public chiefly on account of their enormous destructive effects, to the engineer they may possess interest for other reasons. They go to show that where for any reason the conditions governing the runoff from any drainage area are subject to change, the highest flood mark of the past is no safe guide for the future when permanent structures are to be placed. Lessons of use to those having the construction of bridges and culverts may also be drawn, and such structures be designed as will pass beneath them the enormous volumes of water which some unusual combination of causes may set free on the area above them.

For these reasons the writer has used all the means in his power to obtain such information and it is presented below, though with diffidence, for the possibility of considerable error is great, but the results are the best that can be obtained under the existing circumstances.

Several gagings of this stream have been made at low stages of flow, these indicating an extreme low water discharge of from 8 to 10 cu.ft. per second at Bakersville,with an average low water discharge of from 20 to 22 cu. ft. per second. Unfortunately no gagings of this stream at anything approaching flood heights have ever been made, so that a rating table giving the relation between height and discharge cannot be constructed in the usual manner. Failing in this, therefore, there are two approximate methods which can be used for obtaining this information, one based on the consideration of the amount of the rainfall during the period, its distribution, the condition of the earth as to saturation, etc., together with the shape of the basin, its average slope and the general topography; the second based on the cross-section of the channel at some point, its condition as to roughness and the slope for some distance above and below the point where the cross-section is taken.

In regard to the application of the first method outlined above to this place it may be stated that the total amount of the rainfall cannot be given with accuracy, for the reason that there are no rainfall stations anywhere in the basin drained by this stream, nor are there such for some distance to the north and west. There is, however, an unofficial record of 8 ins. in 12 hours of this day, made at Cranberry about 30 miles to the northwest; and an official record of 7.25 ins. in 24 hours, including part of this day, made at Marion, about 30 miles to the southward. It therefore seems within the bounds of probability that the rainfall over this basin must have been near 8 ins. in the 24 hours under consideration, and this at a time when from all accounts the earth was in a condition of complete saturation, as events to be described later will show. Making the assumption that this amount is nearly correct and assuming further that it found its way to the stream in the same time, which is warranted by the condition of soil and topography, an average discharge of 190 cu. ft. per second will be obtained for every square mile of drainage area above Bakersville, and a total discharge of 404,794,368 cu. ft. of water for the 24 hours. This method, however, furnishes no means whereby the maximum discharge may be determined.

Soon after this flood the writer made a reconnoissance of the drainage basin, measured the flood cross-section and determined the slope of the channel for some distance above and below the town, making at the same time sufficient observations of the condition of the bed and flood plain to determine approximately values for the co-efficient of roughness, the "n" of Kutter's formula, which presented the only means for determining with any approach to accuracy the average and maximum flood discharges. This method is open to objection on the ground that there is great difficulty in selecting the proper value of "n," and also from the fact that the slope at flood stages is probably not the same as at low water, except at the crest of the flood, when the water is neither rising nor falling. There is a possibility, however, that in the consideration of a period like this the errors due to this cause may tend to compensate each other, the slope being greater than at low water while the stream is rising and less as it falls.

From this study of the basin, the slope and the cross-section, which was accurately determined from all stages of the stream, a rating table has been construed and applied to the observed stream heights on the day of the flood. This table is as follows:

Height above low water.	Discharge in cu. ft. per sec.	Height above low water.	Discharge in cu. ft. per sec.
0.0	20	7.0	9,100
1.0	190	8.0	12,400
2.0	650	9.0	15,780
3.0	1,300	10.0	22,450
4.0	2,200	11.0	29,120
5.0	3,300	11.2	30,408
6.0	5,850		

The condition of the stream on the day beginning at 7 p. m. May 19, and ending at 8 p. m., May 20, is stated by the citizens of Bakersville to have been as follows: On May 19 there was sufficient rain to raise the creek to a height about 1 ft. above low water, which stage was maintained until about 7 a. m., May 20. About this time the stream began to rise and rose steadily until 11 a. m., being at this time about 8 ft. above low water. Shortly before this time the rain ceased, and the stream began falling, and by noon had fallen 1.5 ft. At this time, however, it began raining again, harder, it is said, than was ever seen in this country before and the creek rose very rapidly to a height of about 11.5 ft. above extreme low water, rising the last 4 ft. in half an hour, with extreme high water about 1 p. m. The fall was rapid, by 8 p. m. the stream having regained a level about 1 ft. above ordinary low water. From this statement a profile of the flood was platted and the mean height deduced for each hour interval in the 25 hours under consideration, with the following result:

Time.	Mean discharge, cu. ft. per sec.	Time.	Mean discharge, cu. ft. per sec.
7 p.m. to 7 a.m.	190	1 p.m. to 2 p.m.	26,450
7 a.m. " 8 "	466	2 " " 3 "	17,115
8 " " 9 "	1,660	3 " " 4 "	11,080
9 " " 10 "	3,585	4 " " 5 "	5,975
10 " " 11 "	9,160	5 " " 6 "	2,800
11 " " 12 noon	9,760	6 " " 7 "	1,390
12 noon " 1 p.m.	15,100	7 " " 8 "	510

The total discharge, therefore, computed on this basis is 386,535,600 cu. ft., which checks sufficiently well with the aggregate based on the amount of rainfall.

The average flood in this stream, therefore, may be stated at about 5,800 sec.-ft., with possibly 12,000 sec.-ft. for the greatest rises heretofore, which have been about 8 ft. At the maximum the quantity of water carried by this stream during this great flood cannot have fallen far short of 30,500 cu. ft. per second, or a discharge of 1,341 cu. ft. per second per square mile of drainage area above the town of Bakersville. This is equal to a discharge of 39,900 sec.-ft. at the mouth, though it is not probable that the area below Bakersville discharged at a rate equal to that above.

Besides the floods Mitchell Co. suffered from both landslides and so-called waterspouts. As many as 17 small landslides were counted on the side of a single hill. A portion of what Mr. Myers says about these waterspouts is substantially as follows:

The waterspouts seen in Mitchell county varied only in the size of the cavity left by them, the attendant phenomena being apparently the same in all cases. One of the largest seen or heard of was very thoroughly investigated and will be described as typical of all. Its form and dimensions are shown in the accompanying sketch, Fig. 5. As shown, the excavated area was roughly heart-shaped, having an extreme breadth of about 100 ft., the distance from head to point being about 300 ft., and it was located on a hillside, sloping from 30° to 45°, and having its head about 200 ft. below the crest of the hill, which was as high as any nearby. The side of the hill was level transversely. From the lower end of the cavity a sharp and well-defined channel led down the hill to the stream at the base, this channel being from 5 to 6 ft. wide and from 4 to 5 ft. deep, with side walls practically vertical, cut down through a gravelly clay. The general appearance of the excavation is shown in the accompanying views, Figs. 6 and 7. It is estimated that the excavation has a total content of about 2,500 cu. yds. of earth which seems to have disappeared utterly. In addition the area was timber-clad, though with a rather sparse growth. The trees have been uprooted and carried downhill, trunks of from 50 to 60 ft. in length and 2 to 3 ft. in diameter having been left from 100 to 300 ft. below the lower end of the excavation, while the smaller trees were carried to the stream at the base of the hill, the trees and other debris from this area wrecking a small log-house that stood in their course.

Another large waterspout not far from this was visited where the excavation was even larger. Near the sides of this the trees left standing were covered with mud to a height of 6 or 7 ft. from the ground.

It is evident that an enormous quantity of water must have flowed from these excavations in a very short time, the greater part certainly of subterranean origin, as is evidenced by the honeycombed condition of the earth about the head and sides of each of these places, and also by the fact that within a few feet of these outbursts quantities of dead leaves and small chips are to be observed, which would certainly have been carried away if the water were all from sources above the surface.

However, from the testimony of many of the inhabitants of the region it also seems probable that many of these "spouts" were aided in their destructive effects by cloudbursts, an enormous quantity of water being precipitated on a small area in a very short time. Also according to the same testimony the formation of a spout was accompanied by an eruptive force sufficient to throw the earth several feet into the air, and in one place a large stump was seen which it was said had been thrown completely over a country road in this way. No one could be found who saw it so thrown, but the general testimony was that it belonged to one slope and was found on another it could not have rolled of itself.

Some of the smaller spouts were seen in the act of ing out and in these cases the earth is reported risen in a large bubble, as large as a haystack, which burst and come rolling downhill followed by a stream water, which in one instance was said to have been large as a man's leg, and to have flowed for about hours. Around many of these places an odor like that newly exploded dynamite was said to linger for days. This was, however, in all probability the odor fresh moist earth or (else it was due to) imagination.

It may be remarked in conclusion that the inhabitants almost without exception, ascribe the tremendous rush water from these "spouts" to a great storm or other vulsion of nature which forced the water of the ocean the earth and back to the surface again more than miles away, and to elevations of from 2,500 to 3,000 ft. other sections the heavy rainstorms are said to be due the 17-year locusts, which appear this year with the letter "W" on their wings, the "W" standing, in this case, for "water."

THE JUNE FLOOD IN ELKHORN CREEK, W. VA.

What has preceded relates to the May floods in North and South Carolina. The June flood, in West Virginia, was mainly local, and was more violent in the basin of Elkhorn Creek.

Elkhorn Creek rises on Great Flat Top Mt. and flows northwesterly about 22 miles to Big Sandy River. It drains about 81 sq. miles, of which 44 is above Keystone. A little above Keystone the main stream, with a drainage area, thus far, of about 18 sq. miles, is joined by the North Fork, which drains 21.5 sq. miles. The valley is devoted largely to mining and shipping semi-bituminous Pocahontas coal. About 50 lives were lost by the Elkhorn Creek flood, and the number would have been greater had the high water come in the night. Many dwellings, mostly cheap cabins, were washed away; miles of track were practically destroyed, together with culverts and bridges; tracks and yards were covered with sand and cars were overturned.

The drainage area of Elkhorn Creek is composed largely of exposed rock and of thin soil on steep, sparsely-wooded slopes. For some days prior to June 22 the weather had been so rainy that the soil was probably thoroughly saturated. From about 1 to 6 a. m., June 22, a series of heavy thunderstorms occurred, while from 6 to 8 a. m. "it rained, it is said, harder than was ever seen by any one in this section before." The only weather bureau station in this drainage area is at Elkhorn, where 5.14 ins. of rain fell in 14 hours of the night, June 21-2. It is probable that at higher elevations the precipitation was greater and that more than 6 ins. fell throughout the whole area above Keystone. The residents reported cloudbursts, and there were evidences of such at a number of places. The rise of the creek at Keystone is said to have been 4 ft. in less than 15 minutes. From 7.30 to 9.30 a. m., June 22, it is said that the creek rose from 2 or 3 ft. to 20 ft. above low water, flooding the entire town to a depth of 3 ft. or more. At 10 a. m. the water began to fall, and by 2 p. m. the stream had nearly reached its normal level. About a week after the flood the discharge of the stream at its mouth was only about 25 sec.-ft., and at Keystone it was probably about 15 ft.

Mr. Myers assumes 6 ins. rainfall and runoff in 14 hours over the entire drainage area of 44 sq. miles above Keystone, giving a total flood discharge of 615,524,800 cu. ft., or an average of nearly 278 sec.-ft. per sq. mile. He concludes his estimates and also his report, as follows:

As stated before, in this way no estimate of the maximum flood volume is possible and we are compelled to resort to estimates based on the slope and cross-section of the channel. Such estimates in this case present even greater difficulties than in the case of Cane Creek, since the waters of Elkhorn Creek were much more obstructed and the cross-section at different points is much more variable, making the coefficient of roughness greater than before, and introducing more uncertainty as to its proper value. As the method used was precisely the same as that used on Cane Creek, the calculations will not be given here in detail as on that stream. The computations indicate an extreme flood discharge of about 60,000 cu. ft. per second, or a flow of 1,363 cu. ft. per second per square mile of drainage area above Keystone, and a total quantity of 626,920,000 cu. ft. of water discharged by this stream in 14 hours, which checks sufficiently well with the computation of the same quantity based on the amount of the probable rainfall. It seems probable, therefore, that the figures given are approximately correct.

The loss caused by this flood in this valley alone is estimated to have been between $900,000 and $1,000,000, of which $500,000 was sustained by the railroad. The entire loss from this flood is estimated to have been about $1,250,000.